

Yellagonga Integrated Catchment Management Plan 2014-2019



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ABBREVIATIONS

ANZECC	Australian and New Zealand Environment Conservation Council
ASS	Acid Sulphate Soils
CCW	Conservation Category Wetlands
CoJ	City of Joondalup
CoW	City of Wanneroo
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DPS2	District Planning Scheme No. 2
ECU	Edith Cowan University
EWR	Ecological Water Requirements
EWSP	East Wanneroo Structure Plan
LBS	Local Biodiversity Strategy
LEP	Local Environment Plan
LPP	Local Planning Policy
MRS	Metropolitan Region Scheme
NCCARF	National Climate Change Adaptation Research Facility
WAPC	Western Australian Planning Commission
WCP	Water Conservation Plan
YICM	Yellagonga Integrated Catchment Management
YRPM	Yellagonga Regional Park Management

EXECUTIVE SUMMARY

Yellagonga Regional Park is one of eight regional parks within the Perth Metropolitan area and lies on the Swan Coastal Plain located approximately 20km north of Perth. Yellagonga Regional Park consists of a wetland chain including, from north to south, Lake Joondalup, Beenyup Swamp, Walluburnup Swamp and Lake Goollelal.¹

The Yellagonga Regional Park (the Park) is jointly managed by the Department of Parks and Wildlife, and the Cities of Joondalup and Wanneroo (the boundary of which passes through these wetlands). Land tenure is also vested in the Conservation Commission of Western Australia and the Western Australian Planning Commission.

The Park's co-managers, the Cities of Joondalup and Wanneroo and the Department of Parks and Wildlife (DPaW) recognise that land use practices in the surrounding catchment, from both past and present activities, can have detrimental effects on the wetlands of the Yellagonga Regional Park and that it is the shared responsibility of the Park co-managers to address the threats impacting the health of the Yellagonga Catchment Area. Impacts include water quality and quantity entering the wetlands and threats to the ecological integrity and biodiversity of the Park.

In order to maintain and enhance the amenity, recreational, educational, scientific, and conservation values of Yellagonga Regional Park, for present and future generations, the *Yellagonga Integrated Catchment Management Plan 2009-2014* (YICM Plan) was developed to provide a comprehensive and integrated approach to managing the Park. The Plan was developed following extensive consultation with and guidance from a Community Reference Group and Technical Working Group.

Part 1 of the YICM Plan document detailed the research and information collected during the development of the Plan and provided an assessment of both the Park and Catchment Area. Part 2 of the Plan was developed as an Implementation Plan with projects to be delivered within the Catchment to mitigate the key threatening processes and issues identified affecting Yellagonga Regional Park.

Following implementation of the Plan a detailed review of the *Yellagonga Integrated Catchment Management Plan 2009-2014* was undertaken in April 2014 whereby progress made in delivering projects within the Plan was assessed. Following this review the Cities of Joondalup and Wanneroo commenced development of the *Yellagonga Integrated Catchment Management Plan 2014-2019*.

This *Yellagonga Integrated Catchment Management Plan (YICM Plan) 2014-2019* provides a holistic and strategic direction for the two Cities to continue to implement a wide range of initiatives aimed to conserve the ecological values of the Yellagonga Regional Park.

Extensive historical and technical information regarding the Yellagonga Catchment Area is contained within the YICM Plan 2009-2014 Part 1 Technical Report. This new YICM Plan

¹ CALM *et al* (2003)

2014-2019 builds on the previous YICM Plan 2009-2014 with a focus on the implementation process with new and ongoing projects being identified that will be implemented over the life of the Plan.

A range of threats to the long-term viability of Yellagonga Regional Park remain, including the drying climate trend, poor water quality, invasive flora and fauna species, wildfires, disease spread, urban encroachment, remaining traditional stormwater drainage, habitat degradation and fragmentation.

Significant progress has been achieved over the past five years to address the key threats to the Park. Key achievements include:

- Regular water quality monitoring and collation of water quality data.
- The delivery of wide ranging community education and ecotourism initiatives.
- Coordinated pest animal control and conservation maintenance schedules.
- Further policy and plan development to direct management actions within the Yellagonga Catchment such as the City of Joondalup's City Water Plan and the City of Wanneroo's Local Planning Policy 4.4: Urban Water Management.

However in order to provide ongoing, conservation gains across the Yellagonga Catchment Area further long term management strategies are required as well as commitment and collaboration from the two Cities and the Department of Parks and Wildlife. The *Yellagonga Integrated Catchment Management Plan 2009-2014* provides the Park's co-managers with detailed direction required to manage the Catchment Area in a sustainable manner to ensure the long term protection of the Park for future generations.

The YICM Plan 2014-2019 will be implemented by the Cities of Joondalup and Wanneroo with significant input and liaison with the DPaW.

1.0 INTRODUCTION

1.1 YELLAGONGA REGIONAL PARK

Yellagonga Regional Park (henceforth referred to as “the Park”) is one of eight Regional Parks within the Perth Metropolitan area and lies on the Swan Coastal Plain located approximately 20km north of Perth.

There are a diversity of interests associated with the Yellagonga Catchment and Regional Park – from residential landowners to those with commercial enterprises and those who use this area for personal recreation, aesthetic enjoyment, historical and cultural heritage – both Aboriginal and European, and those who appreciate the Park for its intrinsic environmental values.

In order to maintain and enhance amenity, recreational, scientific, educational and conservation values of the Park for present and future generations, an integrated catchment approach has been undertaken to provide a comprehensive and integrated approach to managing the Park.

1.1.2 Yellagonga Catchment Area

All water bodies, whether a wetland, lake or river, receive water from the surrounding area. This area from which water flows into the water body is known as the catchment. Effective management of a water body requires management of the surrounding catchment. Integrated catchment management is about balancing use of the land, water and biological resources within a catchment, in a sustainable manner, by encouraging co-operation and co-ordination at all levels of government, in collaboration with the whole community on management of these resources.²

By taking an integrated catchment management approach, the Cities of Joondalup and Wanneroo and the DPaW recognise that activities outside of the Park and its wetland area will impact on the ecological integrity and biodiversity of the Park, particularly through the movement of groundwater, surface water and stormwater. Any land use within the catchment will impact to some extent on the quality and quantity of water entering the Park’s wetlands, as well as impacting on floristic and faunal communities within the Park. The catchment has a diverse range of land uses comprised of residential developments, market gardens, aged care, grassland, orchards, poultry farms, horse agistment, pine tree lots, plant nurseries and various commercial developments (car yards, service stations, shopping centres etc), all of which can impact on the Park.

The Park consists of a wetland chain including, from north to south, Lake Joondalup, Beenyup Swamp, Walluburnup Swamp and Lake Goollelal.³

² Bunny and Mouritz (1995)

³ CALM *et al* (2003)



Figure 1 Location of the Yellagonga Regional Park⁴

The health of the Park and its wetlands is of high importance to both the local and wider communities as well as the stakeholders and organisations responsible for the management of the Park. The Park is identified as having significant regional value, particularly for:

- Providing habitat for flora and fauna including iconic local species such as the Long-necked Turtle, Carnaby's Black-Cockatoo and Graceful Sun-moth;
- Improving ecological function such as air quality, carbon capture, and soil health;
- Decreasing erosion, salinity, water pollution and noise pollution; and
- Providing opportunity for recreational and cultural experiences.

In order to maintain and enhance amenity, recreational, scientific, educational and conservation values of the Park for present and future generations, an integrated catchment approach has been undertaken to provide a comprehensive and integrated approach to managing the Park.

⁴ CALM *et al* (2003)

1.1.3 Tenure and Management Arrangements

The Yellagonga Regional Park is composed of land that is owned or managed by a number of different bodies including the Department of Parks and Wildlife (DPaW), City of Joondalup, City of Wanneroo, Conservation Commission of Western Australia and the Western Australian Planning Commission. There is also a small portion of land that remains privately owned with individual landholders responsible for the management of their own property.⁵

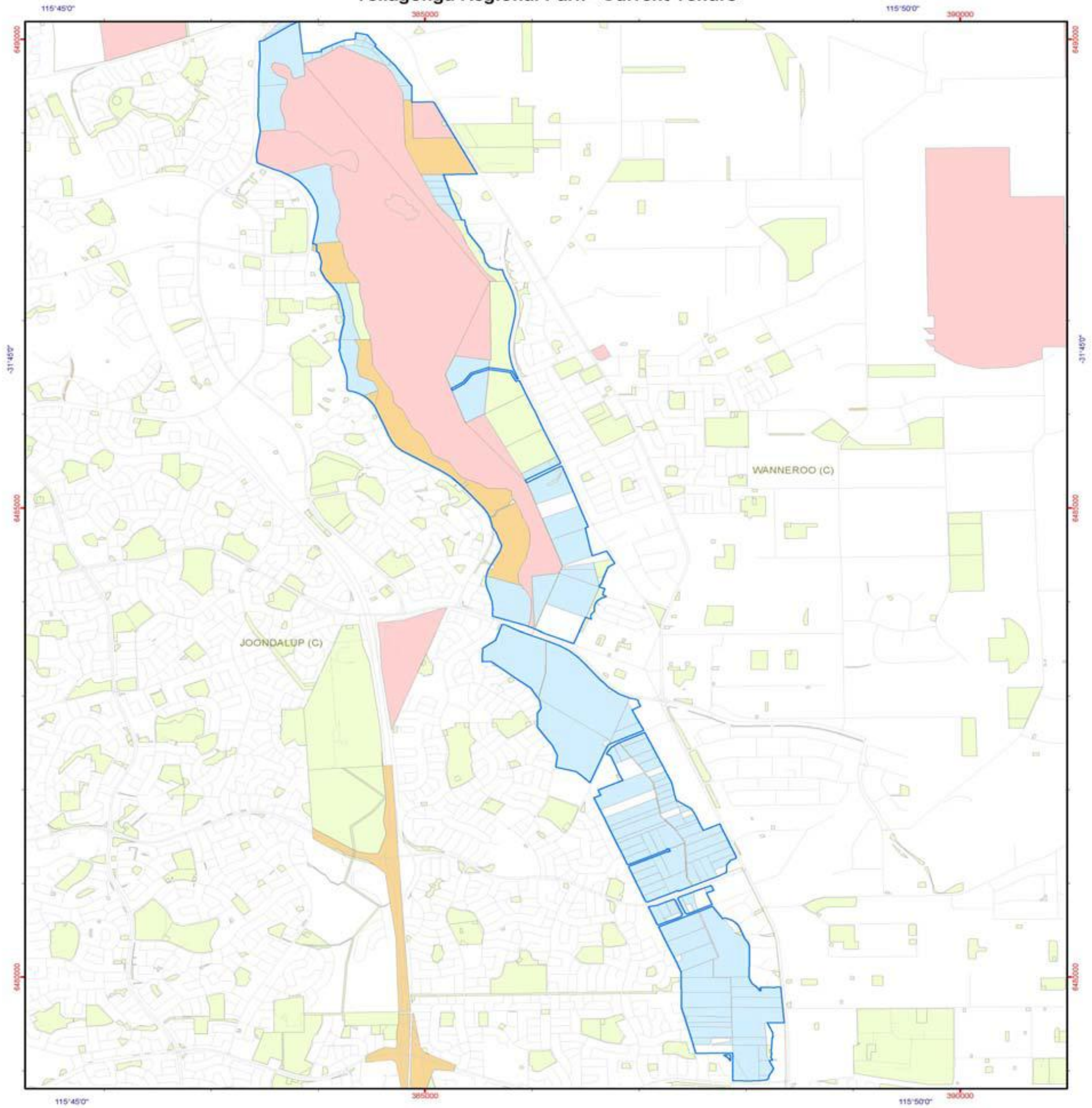
The DPaW is responsible for managing areas of the Park vested in the Conservation Commission of Western Australia and for the overall coordination of the Park's management in accordance with the Yellagonga Regional Park Management (YRPM) Plan 2003-2013. The Cities of Joondalup and Wanneroo manage areas of the Park that are vested in them in accordance with the Management Zones outlined within the YRPM Plan 2003-2013.

While the land tenure for the Park is varied (see Figure 2), the integrated management of the Park is shared by the DPaW and the Cities of Joondalup and Wanneroo. The co-management of the Park is guided by the YRPM Plan 2003-2013. Additionally a Memorandum of Understanding between the City of Joondalup and City of Wanneroo was developed under the YICM Plan 2009-2014 which outlines the key responsibilities for the two Cities in regard to the implementation of integrated catchment management activities.

In addition, there are a number of community groups, including conservation groups who have input into the management of the Park.

⁵ CALM *et al* (2003)

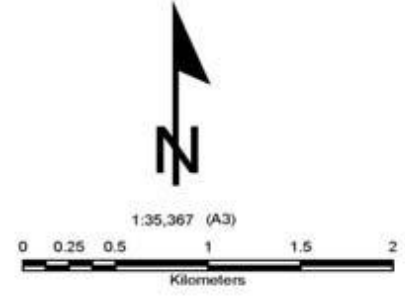
Yellagonga Regional Park - Current Tenure



Graticule shown at 5 minutes intervals
Grid shown at 5000 metre intervals

Legend

- Local Govt. Authorities (LGA)
- Section 16 (WAPC)
- Unallocated Crown Land
- Other Reserve
- CCWA Reserve



Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94



Produced by Regional Parks Unit
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Figure 2 Land Tenure in Yellagonga Regional Park

1.3 BACKGROUND

This current Yellagonga Integrated Catchment Management (YICM) Plan 2014-2019 has been developed within the context of the previous YICM Plan 2009-2014 and the Yellagonga Regional Park Management (YRPM) Plan 2003-2013. The sections below provide background information on these previous plans and how they relate to the current YICM Plan 2014-2019.

1.3.1 Yellagonga Regional Park Management Plan 2003-2013

The YRPM Plan 2003-2013 was developed by the then Department of Conservation and Land Management (now DPaW) and the Cities of Joondalup and Wanneroo, “*to provide broad direction for the protection and enhancement of the conservation, recreation and landscape values of Yellagonga Regional Park*”. One of the ‘High Priority’ strategies proposed in the Management Plan was the preparation of an integrated catchment management plan which was to be consistent with the overall direction of the YRPM Plan 2003-2013.⁶

The YICM Plan 2014-2019 addresses the activities being undertaken within the catchment that affect the Park, while management of the Park itself is guided by the YRPM Plan 2003-2013.

The YRPM Plan 2003-2013 is still considered current in its content and management strategies and therefore is still being utilised to guide the management of the Yellagonga Regional Park.

1.3.1 Yellagonga Integrated Catchment Management Plan 2009-2014

The development of the YICM Plan 2009-2014 and associated catchment management projects was initiated through a Partnership Agreement between the Cities of Joondalup and Wanneroo, who jointly funded the project, and involved considerable input from the community and key stakeholders. This included two community workshops and the establishment and involvement of a Community Reference Group and a Technical Working Group. Key stakeholders included Friends of Yellagonga, Edith Cowan University, the then Department of Environment and Conservation (now DPaW) and the Department of Water (DoW).

Key outcomes from the community consultation process that informed the development of the YICM Plan 2009-2014 were the identification of key threats (see Figure 3) and the development of a community vision (see Figure 4). Further details of the community consultation process and outcomes can be found in the YICM Plan 2009-2014.

⁶ CALM *et al* (2003), pp.1-2

KEY THREATS TO YELLAGONGA REGIONAL PARK IDENTIFIED IN THE YICM PLAN 2009-2014

1. Contaminants
2. Inappropriate infrastructure
3. Urbanisation (development and planning)
4. Climate change and hydrology
5. Weeds
6. Impacts of introduced animals and pests
7. Lack of community education and awareness
8. Incidences of vandalism and rubbish dumping
9. Habitat destruction and fragmentation
10. Lack of understanding of fauna populations
11. Disease

Figure 3 Key threats identified in the YICM Plan 2009-2014

VISION STATEMENT

*That activities in the catchment will support and give rise to:
“the conservation and rehabilitation of an endemically bio-diverse, quality, and sustainably managed Regional Park with the necessary infrastructure for the enjoyment and education of the whole community.”*

Figure 4 Vision Statement developed for the YICM Plan 2009-2014 by the Community Reference Group

The YICM Plan 2009-14 comprised two parts. Part 1 provided a technical report on the research and information collected during the two-year planning process and provided an assessment of the health of the Park and the Catchment Area. Part 2 provided an Implementation Plan and included 18 projects to be implemented within the Catchment over the life of the Plan to mitigate the key threatening processes and issues identified within the Yellagonga Regional Park.

With the implementation of the YICM Plan 2009-2014 scheduled for completion at the end of the 2013-2014 financial year, a review of the Plan and its implementation has been undertaken. This review has measured progress towards the completion of projects, identified key achievements and has guided the development of the YICM Plan 2014-2019.

Substantial progress has been made in implementing projects within the YICM Plan 2009-2014. Full details of the progress of projects are provided in Appendix 1.

1.4 YELLAGONGA INTEGRATED CATCHMENT MANAGEMENT PLAN 2014-2019

Following the implementation and review of the YICM Plan 2009-2014 a new Plan to guide management of the Yellagonga Catchment has been developed. The YICM Plan 2014-2019 builds on the progress made during implementation of the previous Plan and provides further management recommendations to ensure the long term protection of the Yellagonga Regional Park with a focus on addressing the current and future impacts of climate change.

1.4.1 Aim and Objectives of the Plan

The aim of the YICM Plan 2014-2019 is to provide a holistic and long-term strategic plan to improve catchment health and protect the diverse values of the Park.

The objectives of the YICM Plan 2014-2019 are:

- Objective 1: To build upon the achievements, experiences and outcomes of the YICM Plan 2014-2019 and continue to implement an integrated and effective approach to catchment management.
- Objective 2: To work in partnership with key stakeholders to improve catchment management and protect and enhance the ecological values of the Yellagonga Regional Park.
- Objective 3: Ensure positive environmental, social and economic outcomes for the Yellagonga Regional Park and its wetlands.
- Objective 4: Consider the long term protection of the Yellagonga Regional Park with a focus on addressing the current and future impacts of climate change.

1.4.2 Scope of the Plan

The YICM Plan 2009-2014 aims to build upon the outcomes of the previous Plan to provide a guide for continuing to implement an integrated catchment management approach for the Yellagonga Catchment Area. As such the YICM Plan 2014-2019 will:

- Continue to use the outcomes of the original community consultation process and technical review of scientific literature to inform its implementation;
- Provide a brief overview of the Yellagonga Catchment and its environmental condition;
- Outline key achievements from the implementation of the YICM Plan 2009-2014;
- Identify new and ongoing projects that continue the integrated catchment management approach; and
- Provide opportunity for stakeholder and community input into the delivery of projects within the YICM Plan 2014-2019.

Responsibility for implementation of the YICM Plan 2014-2019 lies primarily with the Cities of Wanneroo and Joondalup. The DPaW is a key partner in the delivery of a number of projects within the Plan that relate to the health of ecosystems within Yellagonga Regional Park. The implementation of the Plan will be more effective if strong partnerships with other government bodies including DPaW, educational institutions and the local community are

maintained.

In 2013 the Yellagonga Catchment Working Group, comprised of representatives from the Cities of Joondalup and Wanneroo and DPaW, was established to assist communications and commitment in working collaboratively on the YICM Plan. The Yellagonga Catchment Working Group focuses on key projects requiring collaboration from the three managing agencies.

1.4.3 Structure of the Plan

The YICM Plan 2014-2019 is comprised of four sections.

Section 1 Introduction - provides an introduction to the Plan including aim and objectives, background to the Plan's development, scope and strategic context to the Plan.

Section 2 Yellagonga Catchment Area - provides an overview of the Yellagonga Catchment and its hydrology, water quality, biodiversity and threatening processes. However it does not replace the extensive literature review contained within the YICM Plan 2009-2014.

Section 3 Implementation Plan – outlines five Key Focus Areas of the Plan, identifies issues and objectives and details a project-based implementation framework with specific catchment management projects to be implemented over the life of the Plan to achieve the stated objectives. These include joint projects, delivered in partnership by the Cities of Joondalup and Wanneroo, and individual projects that are implemented by either the City of Joondalup or the City of Wanneroo.

Section 4 Project Details – details each of the projects identified in Section 3 including project description, scope and approach.

1.5 STRATEGIC CONTEXT

The management of the Yellagonga wetlands catchment and the implementation of the YICM Plan 2014-2019 needs to consider the strategic context in which it operates including international legislation, Federal policy and legislation, State policy and legislation, regional policy and local law and policy. Details of the relevant local, State and Federal plans and strategies are provided in Appendix 2.

2.0 YELLAGONGA CATCHMENT AREA

2.1 INTRODUCTION

The Park catchment lies on the Swan Coastal Plain and is located approximately 20 km north of central Perth. The surface water catchment area impacting on the Park is estimated to cover an area of approximately 4000 hectares.⁷ The catchment is linked to the Park by surface flows via drainage infrastructure and groundwater flows. The catchment encompasses land on either side of the Park located in the Cities of Joondalup and Wanneroo and includes medium to high-density residential, commercial and light industrial development interspersed with green areas. Lakes Joondalup and Goollelal, and the swamps Beenyup and Walluburnup, are the receiving aquatic environments for water from this catchment via surface and groundwater flows.

Climate of the Swan Coastal Plain is described as being Mediterranean characterised by long hot dry summers and a shorter period of wet winter months. The annual mean maximum temperature is 24.4°C and the annual mean minimum temperature is 12.1°C. The hottest months are January (average of 31.7°C) and February (average of 31.9°C). The mean annual rainfall is 772.8mm with the wettest months being June (160.1mm) and July (156.8mm).⁸

Soils and geology of the Perth metropolitan north-west corridor have been described by McArthur and Bartle (1975-76). They describe the Park and catchment as lying over quarternary deposits known as the Spearwood Dune System, which presents as a low hilly and undulating landscape. The wetlands and surrounding catchment lies predominantly over Spearwood sand with some areas of Karrakatta limestone and Karrakatta sand. The Spearwood sands consist of some limestone outcrops with shallow brown soils and the Karrakatta limestone is characterised by bare limestone or shallow siliceous or calcareous sand over limestone. The Karrakatta sand is yellow and limestone usually lies beneath this layer.⁹

A brief outline of the features of the Yellagonga Catchment and Regional Park are detailed below. Full details of the key components of the Yellagonga Catchment can be found in the YICM Plan 2009-2014 Part 1 Technical Report.

2.3 HYDROLOGY

2.3.1 Groundwater flow and levels

Groundwater flows from northeast to southwest across the Swan Coastal Plain towards the Indian Ocean.¹⁰ Inputs into the groundwater from land uses many kilometres to the east could eventually see impacts on the Park's wetlands. While a groundwater catchment boundary has not been developed, strategies can still be developed to address potential land use impacts on groundwater - particularly given the high groundwater recharge rates

⁷ Ove Arup and Partners (1994)

⁸ Bureau of Meteorology (2014)

⁹ McArthur and Bartle (1975-76)

¹⁰ Department of Environment (2004)

found on the Gngangara Mound. The highest recharge rates occur over the Gngangara Mound, and range from 15-20 percent, reaching as high as 40 percent of rainfall as total net recharge,¹¹ which highlights the rapidity that any contaminants from landuse over the Gngangara Mound may leach to groundwater.

Steep groundwater gradients occur to the east and west of the lake system and are steepest on the west side of the wetland system, becoming shallow heading west towards the ocean.¹² Given the relatively slow rate of groundwater flow, residence time of groundwater has implications for pollutant concentrations held within the lake systems.

2.3.2 Surface Water

Wetlands on the Swan Coastal Plain are generally surface expressions of an unconfined aquifer with water levels reflecting the rising and falling groundwater levels.¹³ In the past, Lakes Joondalup and Goollelal have fluctuated and followed natural cycles of drying and filling, displaying patterns of long-term seasonal fluctuations according to climatic conditions.¹⁴ However in more recent times, Hamann (1992) suggests the wetlands are not exact surface expressions of the Gngangara groundwater system due to seasonal fluctuations in wetland depth that does not match seasonal changes in the groundwater table. The research has suggested that since urbanisation post 1975, an increasing volume of surface water has entered the wetlands via impervious and cleared surfaces, resulting in deeper lake systems. The drying climate trend however, indicates that there will be reduced surface water expression from groundwater and rainfall. Figure 5 provides an indicative surface water catchment boundary and the three Department of Water hydrographic subcatchments for Yellagonga Regional Park.

¹¹ Department of Water (2008a)

¹² Congdon (1979)

¹³ Allen (1976)

¹⁴ Hamann (1992)



Figure 5 Indicative Surface Water Catchment Boundary

Surface flow through the Park's wetlands moves from south to north, but, as this habitat is now separated by roads dividing it into three sections; culverts and tunnels have been constructed to enable the surface water flow to mimic the natural hydrological regime. Water drains from Lake Goollelal into Walluburnup Swamp via a culvert under Hocking Road and Whitfords Avenue and flows north into Beenyup Swamp. Ocean Reef Road bisects Lake Joondalup into north and south sections. Flow between the two sections only occurs during the winter months via a culvert. There is no surface outflow from this wetland chain but outflow occurs via groundwater in an east to west direction.¹⁵

2.3.3 Drainage

In a natural system, rainfall would infiltrate directly to groundwater with limited overland flow to wetlands. However, urbanisation has resulted in constructed roads and other impervious surfaces, with traditional piped drainage networks and altered topography causing a significant alteration to the natural hydrological regime. For the Park's wetlands, urbanisation has resulted in increased surface water run-off through drainage networks, bringing with it polluted water.¹⁶

In the current climate of diminished rainfall, increased evaporation and a reduction in recharge to groundwater, impervious surface contributions can be viewed as vital arterial flows for many wetlands, however the wetland ecology would require uncontaminated water entering the lakes.

2.3.4 Stormwater Drains

Stormwater drains are known to contribute significant nutrient loads into wetlands. There are 36 drainage outfalls into the Park, including piped outfalls, swales, sumps, and constructed wetlands. The City of Wanneroo (CoW) manages 22 drains, and the City of Joondalup (CoJ) manages 14. Main Roads Western Australia also manages drains and sumps along Wanneroo Road. Several of these drains feed directly into City of Wanneroo drains, which eventually lead to the Park's wetlands.

The City of Joondalup upgraded all outfalls within the City's boundaries that discharged directly into the Yellagonga Wetlands prior to the previous YICM Plan 2009-2014. This involved redirecting outfalls away from the wetlands with filtering systems. Although the remaining stormwater catchment points are sumps that do not discharge directly into the Park's wetlands, the City has identified the upgrade of these sumps in the Stormwater Drainage Program – Sump Beautification Program to consider for best environmental outcome.

Wangara Sump has been identified as the highest priority for upgrade amongst all stormwater infrastructure on the eastern side of Yellagonga Regional Park. The upgrade of the Wangara Sump is being split into 2 stages, with stage 1 having been constructed and stage 2 currently in the design phase as of the time of writing this reviewed Plan.

The City of Wanneroo commenced the retrofitting of stormwater infrastructure in 2009, beginning with the Wangara Industrial Area. Further upgrades to the stormwater

¹⁵ Ove Arup and Partners (1994)

¹⁶ Kobryn (2001)

infrastructure are scheduled to commence over the next few years within the surface water catchment of the Yellagonga wetlands.

2.4 WATER QUALITY

2.4.1 Pollutants

Contaminants such as heavy metals, surfactants, hydrocarbons, nutrients, suspended solids, litter and pesticides are common substances in urban wetlands.^{17,18,19} Pollutants and contaminants enter the Park's wetlands via stormwater run-off, groundwater flow and, to a lesser extent, rainfall.

Key water quality issues arising from pollutants that can impact on the Park's wetlands include:

- Nutrient enrichment resulting in eutrophication, algal blooms and midge outbreaks.
- Pollutants from toxicants (heavy metals, petroleum products, pesticides and herbicides, industrial and household chemicals) can cause compromised immune systems for wetland fauna, mutations, hormone disruption, reproductive interference, poisoning, injury, and death.
- Pollutants bound to sediments can be re-released in water leading to the mobility of these contaminants throughout food chains with unknown effects of bio-accumulation on wetland fauna. For example heavy metals are mobilised under acidic conditions.
- Sedimentation and suspended solids reduce light penetration leading to restricted plant growth and smothering of flora and fauna.
- Litter is unsightly and can reduce light reaching some plants, with unknown effects of dyes and chemicals from printed materials, and possible choking / ingestion hazards for some wetland fauna such as freshwater turtles and avian fauna.

The legacy issues of past land uses are considered to have an ongoing adverse impact on the Park's wetlands; these include market and commercial gardens, poultry industries and septic tanks. See Figures 6 and 7.

¹⁷ Davis *et al* (1993)

¹⁸ Bunny and Mouritz (1995)

¹⁹ Whitely (2004)

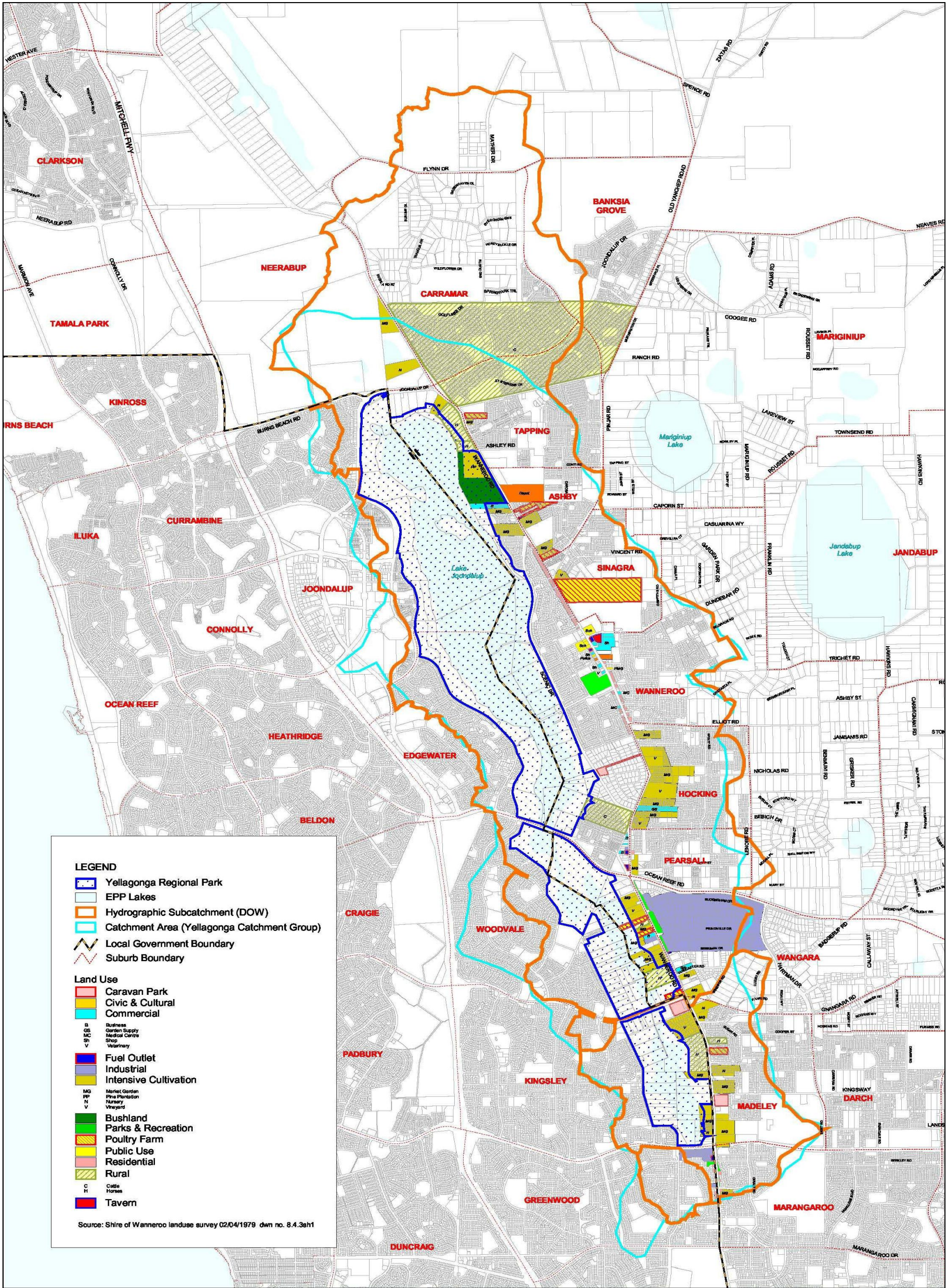


Figure 6 Past Land Uses to the East of Yellagonga Regional Park in 1979

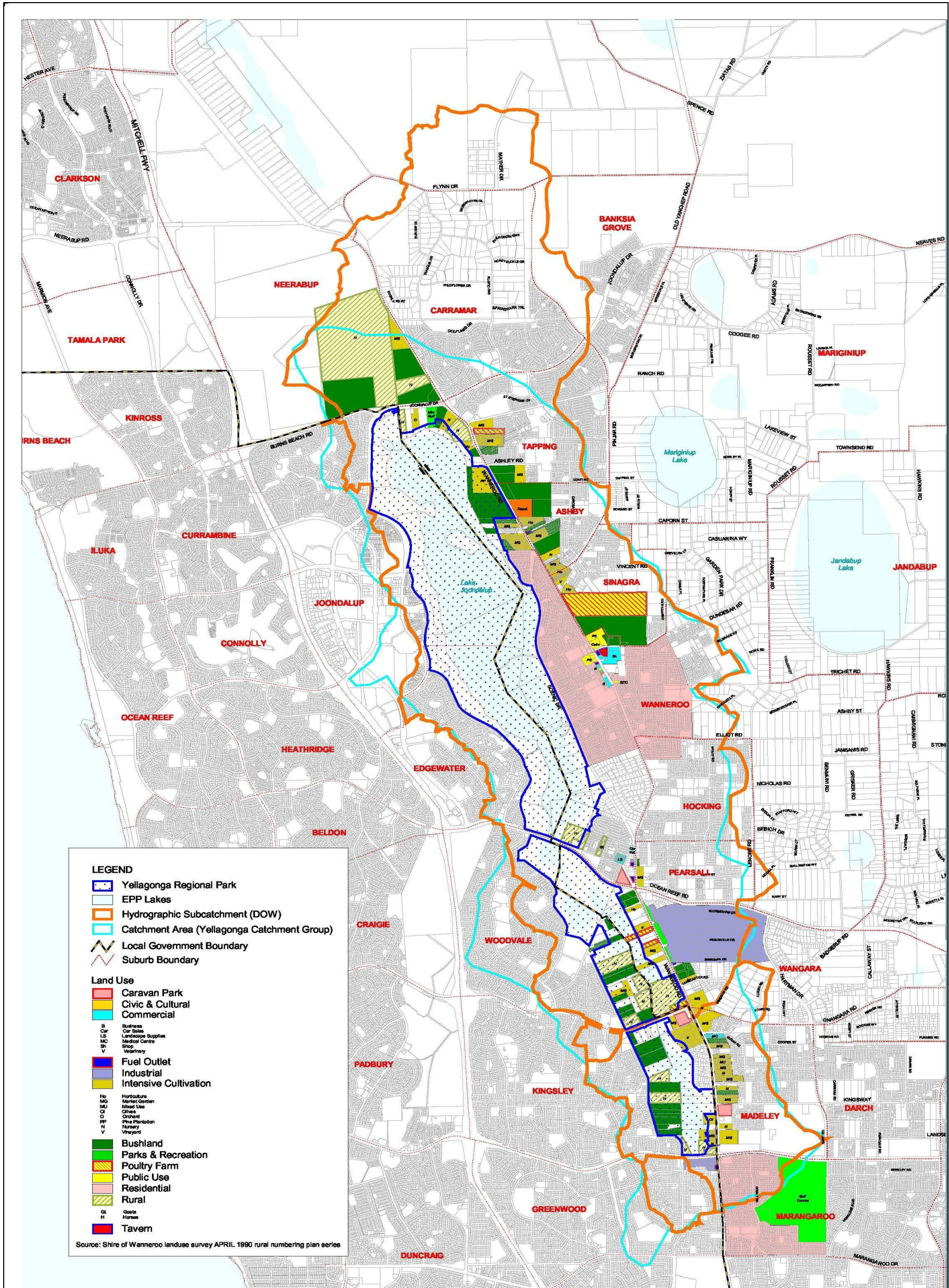


Figure 7 Past Land Uses to the East of Yellagonga Regional Park in 1990

The Wangara Industrial Area is a current land use that may potentially have an adverse impact on the water quality of the Park's wetlands. Untreated stormwater has been draining into a compensating basin on the boundary of Walluburnup Swamp. The stormwater drainage infrastructure in this industrial area is in the process of being retrofitted in order to filter and redirect stormwater away from the Yellagonga Wetlands. Other present land uses include market gardens, septic tanks, diverse commercial uses, residential areas and the high use major and minor roads, which surround the Park. Some drainage subcatchments accommodate significantly more potentially polluting land uses than others as indicated in Figure 8. Pollutants potentially arising from these land uses can also enter the Yellagonga wetlands via groundwater movement.

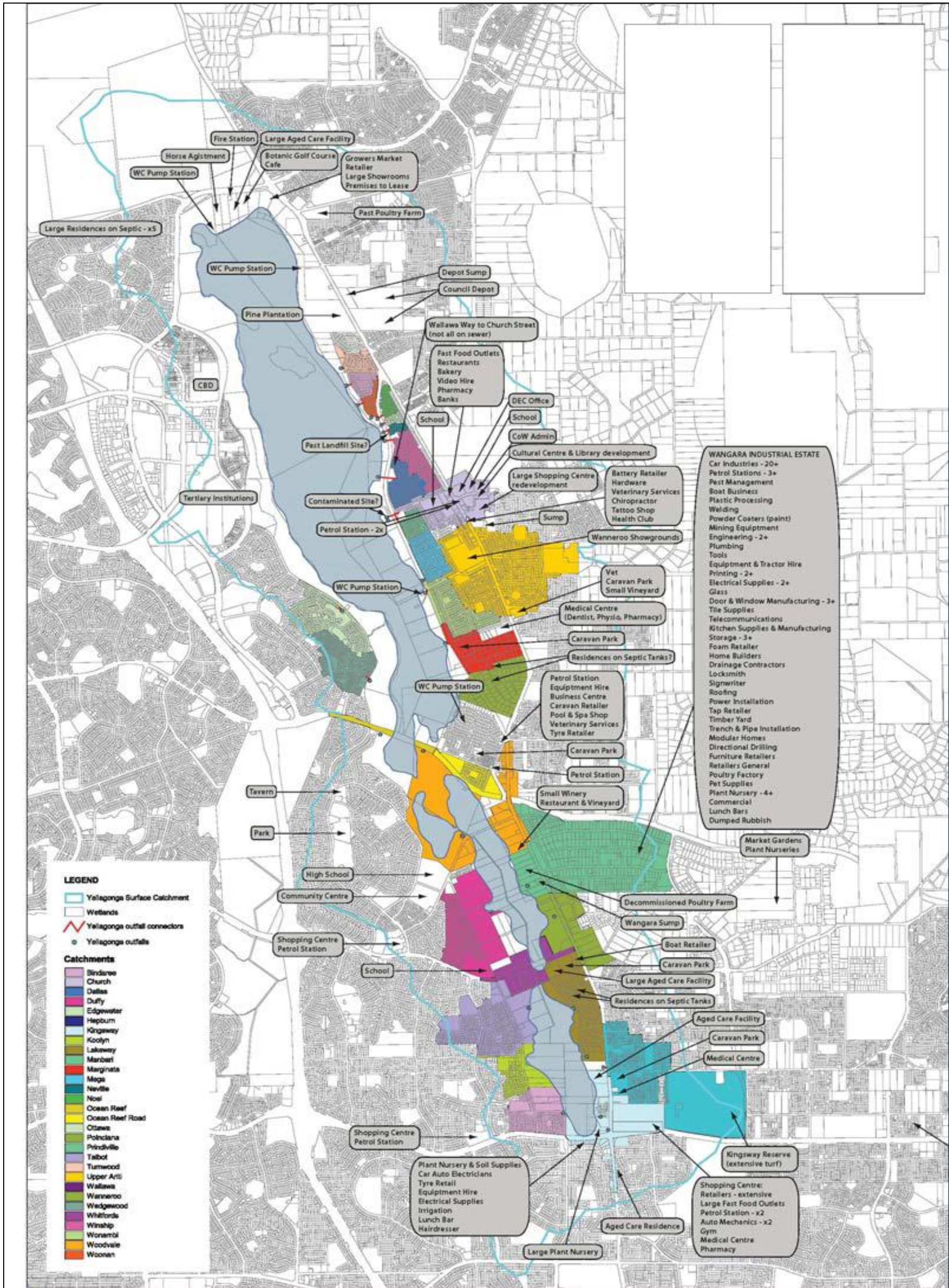


Figure 8 Drainage Sub-catchments in the Yellagonga Catchment Mapped 2008

2.4.2 Monitoring

Further research and monitoring programs of surface and groundwater quality have been undertaken in the Park and in the surrounding catchment by the Edith Cowan University Centre for Ecosystem Management for the YICM Plan 2009-2014 Water Quality Monitoring Program and the Midge Steering Group Partnership research projects.

The monitoring and research have continued to indicate high concentrations of nutrients and heavy metals in the surface and groundwater of the Yellagonga Wetlands that have exceeded the Australian and New Zealand Environment Conservation Council (ANZECC) guideline values (risk to environment). Groundwater has been identified as a major source of nutrients and some metals into the Yellagonga Wetlands, particularly through Beenyup Swamp.

The source of metals around a drain site north of Whitfords Avenue has been identified as being from acid sulphate soils and also from Lake Goollelal where low water levels have resulted in some acidification of the Lake's sediments.

On the ground initiatives have commenced following recommendations from the Edith Cowan University Centre for Ecosystem Management including a site specific acid sulphate soils investigation. Other recommendations to improve water quality that are under consideration include:

- A vegetated bund in the southern section of Lake Joondalup.
- Artificial water maintenance of Lake Goollelal.

The Yellagonga Water Quality Monitoring Program is proposed to continue in the YICM Plan 2014-2019 to provide consistent and comprehensive water quality data, analyses and recommendations upon which sound management decisions can be made.

2.5 BIODIVERSITY

2.5.1 Flora

The vegetation communities within the Park have been identified as nine wetland communities (consisting of sedgelands, woodlands, open and closed forests) and five dryland communities (consisting of open and closed forest as well as woodlands). Much of the remnant vegetation has been altered with only a small area identified as in pristine condition in the northern-most section of the Park found in the *Melaleuca raphiophylla* / *Eucalyptus rudis* closed forest community. Weeds remain a key threat in the Park.²⁰

Three types of emergent vegetation exist within the park – *Baumea articulata*, *Schoenoplectus validus* and the introduced giant reed *Typha orientalis* which is a key threat to native rush communities – particularly in Lake Joondalup and Walluburnup Swamp.²¹

Fringing vegetation around the wetlands is fragmented, with some decline in *Eucalyptus rudis* and *Melaleuca raphiophylla* observed at Lake Goollelal as well as Lake

²⁰ Regeneration Technology (2002)

²¹ CALM *et al* (2003)

Joondalup²². Weed invasion is also evident in the understorey, such as the highly invasive introduced grasses Kikuyu (*Pennisetum clandestinum*), Buffalo (*Stenotaphrum secundatum*) and Couch (*Cynodon dactylon*).²³

A high proportion of the dryland vegetation that once surrounded the Park has been cleared in order to support past and existing land uses such as agriculture and residential development. Tuart-Jarrah-Marri (*Eucalytus gomphocephala* - *Eucalyptus marginata* - *Corymbia calophylla*) open forest exists as a patchy distribution in the west with some open forest to the north east of Lake Joondalup, with scattered Tuarts to the east of Walluburnup and Beenyup Swamps and northeast of Lake Goollelal. Banksia, Jarrah and Marri exists in an open forest along much of the southeastern shore of Lake Joondalup with large areas cleared for recreational landscape along the eastern shores of Walluburnup and Beenyup Swamps and Lake Goollelal.²⁴

2.5.2 Fauna

A formal register of fauna in the Park does not currently exist, however, it is known that within the surface water catchment boundary, at least seven sites with threatened fauna have been identified and many others further east of the boundary have been listed by the DPaW. Two sites have been identified with threatened fauna within the Park.

Three snake species have been sighted in the Park - Tiger snake (*Notechis scutatus*), Carpet python (*Morelia spilota*) and Dugite (*Pseudonaja affinis*).²⁵ Five lizard species have also been identified in the Park (Bamford and Bamford, 1990); the Australian Scincid lizard (*Ctenotus fallens*), Striped skink (*Ctenotus leseurii*), Yellow-bellied skink (*Hemiergis peroni*) and *Lerista praepedita*, as well as the Bobtail lizard (*Tiliqua rugosa*).

The Oblong turtle (*Chelodina oblonga*) exists within the lake systems. In temperate wetlands, freshwater turtles are top end predators and their overall health and presence is important in wetland ecology. Six frog species previously occurred in the Yellagonga Park,²⁶ including the Sandplain froglet (*Crinia insignifera*), Glauert's froglet (*Crinia glauertii*), Moaning frog (*Helioporus eyrei*), Western banjo frog (*Limnodynastes dorsalis*), Slender tree frog (*Litoria adelaidensis*) and the Western bell frog (*Litoria moorei*).²³

Mammals that have been sighted in the Park include the Western Grey Kangaroo (*Macropus fuliginosus*), the Western Brush Wallaby (*Macropus irma*), Southern Brown Bandicoot or Quenda (*Isodon obesulus fusciventer*), Brush-tailed Possum (*Trichosurus vulpecula*), Echidna (*Tachyglossus aculeatus*) and Rakali or native Water-rat (*Hydromys chrysogaster*). Foxes, rabbits and feral cats are pest mammals present in the Park and are discussed in 2.6.9 Introduced Animals.²³

Four fish species have previously been observed in the Yellagonga lake systems – two native and two exotic species. These include the native Swan River Goby (*Pseudogobius olorum*)²⁷ and the Pygmy Perch (*Edelia vittata*).²⁸ The exotic fish being

²² Department of Water (2008b)

²³ CALM *et al* (2003)

²⁴ Regeneration Technology (2002)

²⁵ Australian Government (2014)

²⁶ Bamford and Bamford (1990)

²⁷ Bamford and Bamford (1990)

*Gambusia affinis*²⁷ and the European Carp (*Cyprinus carpio*).²⁹

The Park is important as a summer refuge and breeding habitat for many resident and trans-equatorial migratory water bird species.^{29,30} Over 120 avian species have been recorded in the Park.²⁹ Bekle (1997) identified at least 37 water bird species during 1991-1993 (from the families: Anatidae, Podicipedidae, Anhingidae, Phalacrocoracidae, Pelecanidae, Ardeidae, Plataleidae, Rallidae, Scolopacidae, Recurvirostridae and Charadriidae). Combined results of surveys suggest there may be a decline in water bird species utilising the Park's wetlands. In addition to the water bird species found in the Park, there were 47 species of terrestrial birds identified in the park by Bamford and Bamford (1990).

Kinnear and Garnett (1997a) identified 121 macro-invertebrate taxa excluding the segmented worms (Annelida). The dominant groups were the ten-legged animals (from the order Decapoda such as shrimps and the small crustaceans) and true flies (from the order Diptera such as midges). Considerable variability was found in distributions of macro-invertebrates throughout the wetlands, both spatially and temporally, but the greatest diversity and abundances of macro-invertebrates were typically found at South Lake Joondalup and Beenyup Swamp.

2.6 THREATENING PROCESSES

2.6.1 Climate Change

Current Climate Change

The climate of south-west Western Australia has been undergoing significant change in recent decades. These changes include increased temperatures, increase in sea levels, decrease in rainfall, more intense storm events and increased storm surge.

The long term trend in WA's average temperature has been steadily increasing since the 1950's. Overall, temperature has risen approximately 0.8°C in this time (Climate Commission, 2011). Temperatures appear to be experiencing greater extremes in recent years. The mean number of days over 35°C between 1944–2014, was 27.5, however between 1981–2010 it was 28.5 and in 2012 there were 41.³¹

The south-west of WA has had a 15% reduction in rainfall since the mid-1970s. This is a result of fewer winter low pressure systems, more prevalent high pressure systems and, since 2000, a decrease in the rainfall associated with each system.³²

These changes have already impacted on the Yellagonga catchment and as a result management responses will have to adapt accordingly.

Future Climate Change

Climate change is expected to continue into the future (see Table 1). While the extent of change is dependent on both the amount of greenhouse gases that continue to be emitted

²⁸ WAWA (1995)

²⁹ CALM *et al* (2003)

³⁰ Bekle (2007)

³¹ Bureau of Meteorology (2014)

³² IOCI (2010)

and how the environment responds to changing temperatures it can generally be expected that:

*In 2070 the Yellagonga catchment will have hotter, drier and windier summers with the number of days over 35°C nearly doubling. Winters will be drier, warmer and less windy as a result of fewer low pressure systems.*³³

YELLAGONGA CATCHMENT CLIMATE IN 2070 ³⁴
2.7°C ↑ TEMPERATURE
EXTREME HEAT DAYS ↑ from 28 to 54
19% ↓ RAINFALL
7% ↑ POTENTIAL EVAPORATION
WIND SPEED ↑ 8% IN SUMMER ↓14% IN WINTER
2.0% ↓ RELATIVE HUMIDITY
1.4% ↑ SOLAR RADATION

Table 1 Climate Change Scenario for the Yellagonga Catchment in 2070³⁵

Climate Change Impacts

Predicting the exact scale and nature of climate change at a local level and the resulting impacts is challenging and will depend on the response of local climate systems and the level of future greenhouse gas emissions. The Yellagonga wetlands are situated within the south-west corner of Western Australia, a global biodiversity hotspot and an area particularly vulnerable to climate change.

Expected climate change impacts for Yellagonga wetlands are summarized in Table 2 adapted from the 2011 Report Card on Climate Change and Western Australian Aquatic Ecosystems developed through the National Climate Change Adaptation Research Facility.³⁶

³³ City of Joondalup (2014)

³⁴ Climate Change projections for Perth in 2070 compared to 1990 under a high emissions scenario (A1FI). The projections have been generated using data from 23 climate models and global warming estimates from the IPCC Fourth Assessment Report 2007.

³⁵ CSIRO (2007)

³⁶ NCCARF (2011)

Key Stressors	Anticipated Physical and Chemical Changes	Potential Ecological Consequences
<p>Reduced rainfall</p> <p>Reduced runoff</p> <p>Declining groundwater</p> <p>Increased temperature</p> <p>Changes to seasonality</p>	<p>Reduced water entering aquatic ecosystems via rain, surface runoff or groundwater inflow.</p> <p>Less internal water movement.</p> <p>Increased average and maximum water temperatures.</p> <p>Increased evapotranspiration due to higher temperatures.</p> <p>Changes in rates of chemical processes and equilibria.</p> <p>Reduction in extent, depth and volume of wetlands and waterways.</p> <p>Permanent systems becoming more seasonal and seasonal systems becoming episodic or disappearing.</p> <p>Altered water regime (e.g. delayed onset of winter filling, premature drying, extended dry spells, and unseasonal rainfall due to cyclonic activity).</p> <p>Changes to water quality due to changing quantity and quality of inflows.</p> <p>Acidification through oxidation of acid sulphate soils (due to reducing water levels) and associated release of metals.</p> <p>Increased fire risk (frequency and intensity).</p>	<p>Overall reduction in biodiversity.</p> <p>Progressive change from aquatic to terrestrial species and habitats.</p> <p>Local shifts in species composition. Sensitive species may be lost due to changes in water availability, temperature, and water quality. Increase in temperature tolerant species, existing pests and exotic warm-water species.</p> <p>Potential extinctions of endemic species unable to cope with the rate of change, especially those with poor dispersal mechanisms or in habitats affected by human activity.</p> <p>Plant productivity will be affected by changes in temperature, water quality and higher CO₂ concentrations.</p> <p>Potential increase in algal blooms, anoxia and fish kills. Potential increase in midges and mosquitoes.</p> <p>Potential disruption of reproductive cycles of biota. Changes to seasonal migration triggers. Depletion of seed and egg banks.</p> <p>Altered nutrient and carbon cycles.</p>

Table 2 Expected Climate Change Impacts and Potential Ecological Consequences for Yellagonga Wetland (Adapted from NCCARF, 2011)

2.6.2 Declining Water Levels

Variability is seen in wetland water levels along the Swan Coastal Plain as part of natural cycles of seasonal and annual water fluctuations. However, a drying climate and over abstraction of groundwater from the Gnangara Mound has resulted in declining groundwater levels. Landuse to the east of the Park includes intensive horticultural industries and, in addition, many private bores exist to the east of the Park.

Declining water levels have been shown to alter vegetation compositions (diversity and structure) as well as their biomass. Both native and exotic vegetation that are well adapted to water level variability have been found to predominate, although there appears to be a greater propensity for invasions of monospecific exotic vegetation under declining water levels.³⁷ Declining water levels can reduce the vegetated and lake habitat for the array of wildlife that depends on it.

2.6.3 Water Contaminants

Contaminants impacting on the water quality of the Yellagonga Wetlands are a key threatening process and addressed in 2.3 *Hydrology* and 2.4 *Water Quality*.

2.6.4 Weeds

Weeds are undesirable plants and may include exotic plants or native Australian plants from the Eastern States³⁸ and may also be known as environmental or declared weeds. Given the highly altered landscape of the Yellagonga catchment, invasion of weeds from the catchment into the Park is an ongoing problem. In addition, given the extent of weed growth in the Park, propagation of weeds from within the Park also pose a threat to the ecological integrity of the Park. Weeds produce structural and compositional changes to the vegetation, degrade fauna habitat, and threaten persistence of fauna within the Park. Weeds also invade disturbed habitat, dominating post-fire succession and, in turn, promote susceptibility to fire re-occurrence.

2.6.5 Acid Sulphate Soils

Acid sulphate soils (ASS) are found naturally in the environment and are common around coastal areas, although they do occur inland. Coastal ASS are the result of historic sea level rises, in particular sea level rises during the Holocene (within the last 10,000 years), where sulphate in the seawater mixed with land sediments containing iron-oxides and organic matter forming extensive areas of iron sulfides. When these iron-sulfide rich soils and sediments come into contact with air (for example, through dewatering, excavation, lowered water table etc), the iron sulfides react with water and oxygen to form iron compounds and sulfuric acid.³⁹

³⁷ Hudon (2004)

³⁸ Keighery (2002)

³⁹ DEC (n.d)

In Western Australia, ASS typically occurs in water-logged conditions with soil types that include peat, pale grey Bassendean / Spearwood sands, or coffee rock and also in dark organic rich soils / muds. Soils of the Park and catchment are described as Potential Acid Sulphate Soils, with soils around the Park predicted to be Class 1 'High Risk ASS' occurring within 3m of the soil surface.

Disturbance of ASS results in acidification of surface waters, groundwater aquifers and the soil. Acidification enhances the mobility of metals,⁴⁰ in particular, aluminium and arsenic, which are highly toxic to wetland flora and fauna with potential impacts on human health. Acidic conditions in surface and groundwater can cause damage to infrastructure such as retaining walls, boardwalks, private dwellings as well as death of aquatic organisms in acidified wetlands.

A site specific ASS investigation is being undertaken for the Cities of Joondalup and Wanneroo, however more extensive ASS investigations are proposed in this YICM Plan 2014-2019 to make progress on groundtruthing of acid sulphate soils and develop management strategies as required.

2.6.6 Dieback and Other Plant Pathogens

Dieback is a disease caused by the introduced soil-borne water mould *Phytophthora cinnamomi* and destroys many Australian native plant species in forests, woodlands and heathlands. *Phytophthora* is listed as a key threatening process to Australian biodiversity under the *Environment Protection and Biodiversity Conservation Act (1999)*.⁴¹ The pathogen is spread mostly by human activity and by water movement, and at present, there is no means to eradicate the pathogen. Control of *Phytophthora* is affected by limiting its spread, utilising various methods that prevent the transfer of soil particles, for example washing / scraping hiking boots, camping gear, vehicle tyres and using dedicated wash-bay facilities.

A number of plant species have been identified in the Park as being susceptible to *Phytophthora* dieback including Jarrah (*Eucalyptus marginata*), *Banksia* sp. and Grass trees (*Xanthorrhoea* sp.).

Pathogen management within the Park is to be monitored through the Local Biodiversity Project proposed in this YICM Plan 2014-2019 which includes the City of Joondalup Pathogen Management Plan.

2.6.7 Wildfires

Excessive wildfires commonly caused by arson can devastate the Park's vegetation particularly when the frequency of fires reduces adequate time for natural regeneration. Fauna have nowhere to escape the effects of fire, with loss of life and habitat, increasing their vulnerability to predation and decline. Past practices from Aboriginal burning may not have produced marked changes to ecosystem composition around wetlands,⁴² however today, weed invasion post-fire is an ongoing issue for the Park. Fire also affects soil, which in turn may impact on water quality in wetlands.

⁴⁰ Van der Welle *et al* (2007)

⁴¹ Vear and Dell (2004)

⁴² Bickford and Gell (2005)

Fire management within the Park is to be monitored through the Local Biodiversity Project proposed in this YICM Plan 2014-2019 which includes the City of Joondalup Fire Management Plan. The City of Wanneroo currently manages bushfire through the City's Fire Protection Officers who assess fuel loads in the City's reserves and write prescriptions and undertake prescribed burns accordingly.

2.6.8 Habitat Destruction and Fragmentation

On the Swan Coastal Plain, much of the natural landscape has been cleared for urban development with natural habitat, including wetlands, now existing as small islands in a sea of urbanisation. The Park is separated by Ocean Reef Road and Whitfords Avenue and exists as three areas of natural habitat. While the terrestrial buffer for the most part is greater than 100m, much of this is highly altered with large areas dedicated to grassed parkland. The provision of adequate terrestrial buffers of natural vegetation is vital for overall health and functioning of wetland ecology.

The three separate areas of the Park are surrounded by roads and residential development which has resulted in limited or no opportunities for terrestrial animals to disperse between habitats, restricting contributions into the gene pool or 'rescue' for declining populations.⁴³ Wide-ranging animals are those that are typically vulnerable as fragmentation often results in smaller habitats that cannot provide for all their needs, and these animals are the ones killed as they attempt to cross roads seeking alternative habitat.⁴³

2.6.9 Introduced Animals

Occasional sightings of foxes are made in the vicinity of and within the Park along with rabbits and wild cats. The European red fox (*Vulpes vulpes*) is a non-selective feeder and survives well in a fragmented environment, and particularly well in the urban environment.⁴⁴ Cats also pose a significant threat to the fauna within the Yellagonga Regional Park, whether they are classified as domestic, stray or wild/feral.

While the fox is a declared animal and must be controlled by the land-owner or a local government under the *Agriculture and Related Resources Protection Act 1976*, they need to be removed simultaneously with cats and rabbits. Although foxes and cats are non-selective feeders, both prefer rabbits. Foxes appear to exert some predatory / competitive control over wild cats and, if only foxes are removed, wild cats will slip into this ecological niche.⁴⁵ Further to their introduced status, the interconnectivity between all three species drives the need for simultaneous control. A fox control program facilitated by DPaW has been implemented in coordination with the two Cities and the Yellagonga Regional Park Community Advisory Committee.

Unleashed dogs also negatively impact native fauna populations as they have the potential to chase, disturb and harm wildlife within the Park.

Other introduced animals in the Park include the European honey bee (*Apis mellifera*), the Silver Gull (*Larus novaehollandiae*), Pigeons (Family – Columbidae) and Geese (Family – Anatidae). It is also likely that the Argentine Ant (*Linepithema humile*) is still present. The

⁴³ Noss and Csuti (1997)

⁴⁴ Saunders *et al* (1995)

⁴⁵ Risbey (2000)

European honey bee presence within the Park is predicted to have a detrimental impact on native flora and fauna.⁴⁶

The *Regional Parks Pest and Problem Animal Control Plan (DEC, 2006)* provides recommendations for control methods for major pest and problem animals.

2.6.10 Vandalism and Rubbish Dumping

While the majority of people who recreate within the Park appreciate the environmental and cultural values of the area, the issues of graffiti, dumping of rubbish and other forms of vandalism occur throughout the Park. The DPaW and the two Cities manage graffiti and rubbish removal on an ongoing basis.

Community initiatives such as interpretive signage, information brochures and tours have been designed to raise community awareness of the conservation significance and value of the Park and encourage the responsible use of the area.

⁴⁶ CALM *et al* (2003)

3.0 IMPLEMENTATION PLAN

3.1 KEY FOCUS AREAS

Five Key Focus Areas have been developed to address the key issues in the Yellagonga Catchment. The Key Focus Areas and key issues were developed based on the key threats identified in the YICM Plan 2014-2019 and consideration of the achievements, improved knowledge and outcomes as a result of implementing the YICM Plan 2009-2014. In addition, objectives have been developed for each of the Key Focus Areas and are provided below.

KEY FOCUS AREA	KEY ISSUES	OBJECTIVES
Water Quality	Water contaminants Inappropriate stormwater infrastructure	Improve the water quality of the Yellagonga Wetlands Reduce opportunities for pollutants in water to enter the Yellagonga Wetlands
Urban Planning and Development	Soil contamination Acid sulphate soils Inappropriate stormwater infrastructure	Ensure that integrated catchment management is considered in the land use planning decisions of both Cities Protect the Yellagonga Wetlands from the impact of soil contamination Reduce opportunities for pollutants to enter the Yellagonga Wetlands
Water Quantity	Climate change Reduced water levels Increasing water consumption	To ensure the availability of water for environmental uses within the Yellagonga Wetlands To encourage water conservation within neighboring land uses and the community
Biodiversity	Climate change Risk of pathogens spreading Invasive flora and fauna species Increased incidence and intensity of wildfires Habitat fragmentation and degradation Lack of scientific data on flora and fauna species	To conserve and enhance the biodiversity of the Yellagonga Regional Park to ensure healthy habitats for wildlife Reduce incidences of wildfires within Yellagonga Regional Park Reduce the incidence of weeds and pest animal species in Yellagonga Regional Park Avoid the spread of pathogens and disease within Yellagonga Regional Park
Community and Partnerships	Level of community awareness of the conservation needs of Yellagonga Regional Park Incidences of rubbish dumping and vandalism	Improve the community's awareness and understanding of the Yellagonga Catchment Reduce negative uses of Yellagonga Regional Park

Table 3 Key Focus Areas of the Plan and their Key Issues and Objectives

3.2 YICM PLAN 2014-2019 PROJECTS

In order to achieve the aim and objectives of the YICM Plan 2014-2019, projects have been identified for each of the five Key Focus Areas. These projects will be implemented over the life of the Plan and will be subject to annual monitoring and review. Some of the projects are joint projects between the two Cities and others are individual projects. Each project has a recommended priority based on the below schedule:

- High priority – project commencement in 2014-2015.
- Medium priority – project commencement in 2015-2016.

A summary list of the projects along with their relevant Key Focus Areas and priority for implementation is provided in Table 4 to Table 6.

3.2.1 Joint Projects

PROJECT TITLE	KEY FOCUS AREA	PRIORITY
Water Quality Monitoring	Water Quality	High
Vegetated Bund Construction	Water Quality	High
Water Conservation Project	Water Quantity	High
Midge Steering Group Partnership Research	Water Quality/ Biodiversity	High
Acid Sulphate Soils Management	Water Quality/ Urban Development	High
Local Biodiversity Project	Biodiversity	High
Strategic Partnerships	Community and Partnerships	Medium

Table 4 Joint projects to be Undertaken in Partnership between the Cities of Joondalup and Wanneroo

3.2.2 Individual Projects

City of Wanneroo

PROJECT TITLE	KEY FOCUS AREA	PRIORITY
Yellagonga Ecotourism and Community Awareness Program	Community and Partnerships	Medium
Stormwater Management Plans	Water Quality	High
Contaminated Sites	Water Quality	High
Conservation Maintenance and Capital Works	Biodiversity/ Water Quality	High
Local Planning Framework	Urban Planning and Development	High
Planning Framework for the East Wanneroo Structure Plan	Urban Planning and Development	High

Table 5 Individual Projects to be undertaken by the City of Wanneroo

City of Joondalup

PROJECT TITLE	KEY FOCUS AREA	PRIORITY
Yellagonga Ecotourism and Community Awareness	Community and Partnerships	Medium
Stormwater Management	Water Quality/ Water Quantity	Medium
Conservation Maintenance Schedule	Biodiversity/ Water Quality	High
Climate Change Strategy 2014 - 2019	Water Quality/ Water Quantity/ Biodiversity	High
Review of the City's Local Planning Strategy and Local Planning Scheme	Urban Planning and Development	Medium

Table 6 Individual Projects to be undertaken by the City of Joondalup

3.3 REPORTING AND REVIEW

Annual reviews of the YICM Plan 2014-2019 will identify the progress and efficacy of projects, and have the ability to adapt to emergent issues, reconsidering the priority and scope of projects to ensure major benefits for the Yellagonga Catchment are achieved in the first five years of implementation.

A major five-year review of the YICM Plan will identify further action needed to address additional and emergent threats in the catchment. These additional action areas will inform the subsequent incarnation of the Plan.

The two Cities will have shared responsibility for undertaking the review processes.

4.0 PROJECT DETAILS

4.1 JOINT PROJECTS

Joint projects will be undertaken in partnership between the Cities of Joondalup and Wanneroo.

Water Quality Monitoring Program

Existing Project

Project Description

There are a number of water quality issues arising from groundwater and surface water inputs. These include nutrient enrichment resulting in eutrophication, algal blooms and midge outbreaks; and toxicants such as heavy metals, petroleum products, pesticides, herbicides and industrial / household chemicals.

Monitoring and mapping of water quality entering into Yellagonga wetlands is vital to continued understanding of the movements and concentrations of contaminants.

Edith Cowan University Centre of Ecosystem Management has undertaken surface and groundwater quality monitoring and reporting for the two Cities since 2010. The monitoring provides details on the health of the water quality and recommendations to improve water quality are provided.

The Water Quality Monitoring Program is undertaken in liaison with the Midge Steering Group Partnership Research which shares the same goal of improving water quality.

Project Objectives

- Increase the understanding of contaminant inputs into Yellagonga wetlands.
- Provide data upon which sound management decisions can be made.
- Reduce negative impacts within the Yellagonga Catchment associated with poor water quality.

Scope

The project will:

- Continue scientific monitoring and investigations of groundwater and surface water in the Yellagonga Catchment and Park.
- Support scientific and education programs aimed at identifying and mitigating sources of contaminants.
- Collate, analyse and share data between managing authorities.
- Provide recommendations for on ground actions to improve water quality.

Targets / Timeframes

Quarterly monitoring of surface water and groundwater conducted and the Cities to receive annual reporting of water quality of the Yellagonga Wetlands by the end of June each year. Annual water quality reporting is to be provided to Elected Members by September each year.

Project Partners

Edith Cowan University

DRAFT

New Project

Project Description

The construction of a vegetated bund at a southern section of Lake Joondalup was a key recommendation from the Water Quality Mapping and Monitoring Program undertaken as part of the YICM Plan 2009-2014.

In the context of stormwater drainage in the natural environment, a vegetated bund (also referred to as a flow directing bund) is a constructed vegetated mound ensuring water has a longer path to flow before it is discharged. This is to enable physical and biological treatment to occur such as uptake of excess nutrients into vegetation and sediment. The purpose of the recommended vegetated bund is to redirect polluted water flow around the bund to reduce the level of nutrients (phosphorous and nitrogen) entering the bulk of Lake Joondalup north of Ocean Reef Road. The vegetation of the bund also takes up nutrients. Exceeded levels of nutrients and metals have been recorded through the annual Water Quality Mapping and Monitoring Program.

Added benefits of a vegetated bund planted with appropriate local native vegetation include further conservation enhancement, habitat for wildlife leading to enhanced biodiversity.

Project Objectives

- Improve the quality of water through Beenyup Swamp and Lake Joondalup.
- Enhance the local native vegetation south of Lake Joondalup.
- Provide enhanced habitat for wildlife.

Scope

The project will:

- Investigate a viable vegetated bund construction process based on information from Edith Cowan University.
- Assess costs involved and prepare grant funding if required.
- Involve collaborative planning and design of the vegetated bund with both Cities, DPaW and relevant stakeholders.
- Seek consultancy services if required.
- Deliver the construction, planting and initial maintenance of the vegetated bund.
- Include water quality monitoring before and after the vegetated bund construction.

Targets / Timeframes

Completion of the vegetated bund by December 2016 if identified as a viable project.

Project Partners

Department of Parks and Wildlife

Edith Cowan University

New Project

Project Description

The Yellagonga Wetlands are a groundwater dependant system and impacted by the drying climate trend. Continued reduced rainfall and use of groundwater has the potential to significantly impact on the Yellagonga Wetlands and threaten its future existence. In order to conserve this important wetland region and its inhabitants, a priority focus on water conservation is required, particularly groundwater consumption through bore water abstraction.

Reports provided by Edith Cowan University for the Yellagonga Water Quality Monitoring Program recommended that the preferred minimum water level for the Yellagonga Wetlands be managed and that options for the artificial water maintenance of Lake Goollelal be investigated to avoid acid sulphate soil exposure and contamination caused as a result of drying of the lake. Artificial water maintenance has also been recommended to reduce nutrient enrichment and midge outbreaks which are exacerbated by shallow warm water.

Project Objectives

- Ensure future survival of the Yellagonga Wetlands through water conservation.
- Provide healthy wetland habitat for wildlife.
- Minimise the risk of acid sulphate soil exposure.
- Minimise nutrient enrichment and midge outbreaks

Scope

The project will:

- Liaise with the Department of Parks and Wildlife, Department of Water and the Water Corporation to:
 - Identify the preferred minimum water level guidelines for the management of the Yellagonga Wetlands.
 - Investigate options and feasibility for the artificial water maintenance of Lake Goollelal and consideration for Lake Joondalup further into the future.
- Address Community groundwater consumption by:
 - Identifying residential and commercial bore locations in the Yellagonga Catchment and establishing a community and industry water efficiency education program for suburbs within the Yellagonga Catchment in liaison with the Department of Water.
- Address City groundwater consumption by:
 - Monitoring bores within the Yellagonga Catchment and relevant adjacent areas to identify usage patterns and reduce consumption at these bores. This can be achieved through the City of Joondalup Groundwater Monitoring Program and the City of Wanneroo Water Conservation Plan.

- Implementation of the City of Joondalup *City Water Plan 2012–2015* and the City of Wanneroo *Water Conservation Plan* including the following strategies:
 - Operating within the allocation limits and license conditions of the groundwater extraction licenses issued by the Department of Water.
 - Optimise irrigation efficiency across both Cities, by improving irrigation system performance and irrigation scheduling.
 - Implement water saving practices and technologies that will result in a reduction in groundwater use.
 - Utilise groundwater in a more efficient manner while maintaining the usefulness and attractiveness of public open spaces.
- Adhering to current and future license allocations as specified by the Department of Water.

Targets / Timeframes

- Investigate the feasibility for the artificial water maintenance of Lake Goollelal by December 2015.
- Yellagonga Catchment community and industry water efficiency education program to be established by December 2015.
- City of Joondalup *City Water Plan* projects delivered in accordance with the Council approved *City Water Plan* and annual progress reports presented to Council by December each year.
- City of Wanneroo *Water Conservation Plan* projects delivered in accordance with the Council approved *City Water Conservation Plan* and annual progress reports presented to Council by December each year.

Project Partners

Department of Parks and Wildlife / Department of Environmental Regulation

Department of Water

Existing Project (*previously titled Scientific Investigations*)

Project Description

The City of Joondalup, City of Wanneroo and the Department of Parks and Wildlife, have a formal agreement for managing midge within the wetlands of the Yellagonga Regional Park. This agreement was formalised with the Midge Management Strategy Partnership Agreement. A Midge Steering Group, established as part of the partnership agreement, comprises representatives of each partner agency.

The Agreement is designed to encourage an effective and sustainable partnership for the purpose of managing nuisance midge within the wetland system of the Yellagonga Regional Park. The key objective is:

- 3.1** *For control and management of nuisance midge within the wetland system of the Yellagonga Regional Park, through funding midge larval and water monitoring, nuisance reduction using pesticide application when required, other intervention strategies, research projects in an effort to better understand the factors contributing to the seasonal midge plagues and public information and education.*

This Midge Steering Group Partnership Research project identified in this Plan focuses on the research component. The Midge Steering Group Partnership have organised numerous research projects of the Yellagonga Wetlands undertaken by Edith Cowan University Centre for Ecosystem Management to identify methods of:

1. Improving water quality within Lake Joondalup.
2. Reducing dependence on short term chemical treatments for the management of nuisance midge swarms.

Varied research projects have been developed since 2007 which have continued to indicate excessive quantities and key sources of nutrient inputs into the wetland system. Groundwater has been identified as a likely major source of nutrients into the Yellagonga Wetlands particularly through Beenyup Swamp. Since 2009 this research project has been undertaken in coordination with the YICM Water Quality Mapping and Monitoring Program.

The Midge Steering Group Partnership Research is undertaken in liaison with the Water Quality Monitoring Program which shares the same goal of improving water quality.

Project Objectives

- To better understand the factors contributing to the seasonal midge plagues.
- Identify ways to improve water quality of the Yellagonga Wetlands.
- To consequently reduce midge outbreaks and the requirement of short term chemical treatments for the control of midge.

Scope

The Midge Steering Group will organise research projects that:

- Facilitate a better understanding of the factors contributing to seasonal midge plagues within the wetland system of the Yellagonga Regional Park.

- Assist in understanding the nutrient contributors within the catchment.
- Evaluate alternate intervention strategies for control of midge.

Research will be undertaken in coordination with the Water Quality Monitoring Program.

Targets / Timeframes

Review of the Midge Management Strategy Partnership Agreement undertaken by June 2015.

Project Partners

The Midge Steering Group comprises of the Cities of Joondalup and Wanneroo and the Department of Parks and Wildlife.

DRAFT

Existing Project

Project Description

Soils of Yellagonga Regional Park and Catchment Area are described as Potential Acid Sulphate Soils. If disturbed, acid sulphate soils can release heavy metals into groundwater and contribute to poor water quality and contamination.

To ensure disturbed acid sulphate soils do not negatively impact on the wetlands of Yellagonga Regional Park, the identification and management of disturbed acid sulphate soils is important.

The Water Conservation Project investigation of artificial water maintenance also aims to reduce the risk of acid sulphate soil exposure from the drying of Lake Goollelal.

Project Objectives

- Identify any extent of disturbed acid sulphate soils in the Yellagonga Catchment.
- Develop management strategies to manage impact of any disturbed acid sulphate soils on Yellagonga Regional Park.

Scope

The project will:

- Continue development of an Acid Sulphate Soil Management Plan for Site Goollelal (identified through the Water Quality Monitoring Program).
- Investigate a feasible process to identify any likely areas of acid sulphate soil disturbance in the Yellagonga Catchment.
- Assess the extent of acid sulphate soil disturbance to develop management strategies.

Develop rehabilitation plans for the Cities of Joondalup and Wanneroo managed areas where acid sulphate soils are impacting upon Yellagonga Regional Park.

Targets / Timeframes

Acid Sulphate Soil Management Plan for Site Goollelal developed by 2016.

Rehabilitation Plans in place where required (i.e. where acid sulphate soils have been confirmed as impacting on Yellagonga Regional Park) by June 2019.

Project Partners

Department of Parks and Wildlife.

New Project

Project Description

Within the Yellagonga Catchment Area there are numerous issues that have the potential to adversely impact on the Park's biodiversity values; these include altered fire regimes, weeds, pest animals, pathogens / disease and poor water quality.

While some of these threats are addressed through conservation maintenance schedules and site specific projects managed by the two Cities, Department of Parks and Wildlife and the Friends of Yellagonga, further work is required to address the key threats to the biological diversity of the Yellagonga Regional Park.

Project objectives

- Implement best practice fire management for the Park.
- Reduce the incidence of weeds in the Park.
- Reduce the occurrence of pest animals in the Park.
- Reduce the impact of water pollutants including exceeded levels of metals and other toxicants on wetland fauna.
- Avoid the spread of pathogens and disease within the Park.
- Increase the populations of local native flora.
- Provide optimal habitat for a diversity of wildlife.
- Enhance water quality through biofiltration.

Scope

The project will:

- Seek funding opportunities to undertake fauna and flora surveys in collaboration with the DPaW. These surveys are to include:
 - local native and migratory fauna;
 - pest animal sightings;
 - vegetation condition; and
 - impact of exceeded levels of metals and other toxicants on fauna where possible.
- Identify and plan for sites requiring revegetation / weeding works guided by findings from surveys, conservation maintenance teams, Yellagonga Regional Park Community Advisory Committee and Edith Cowan University recommendations.
- Identify how the following City of Joondalup Management Plans are implemented within the Park and assess any gaps, through the YICM Annual Review process:
 - Fire Management Plan
 - Weed Management Plan
 - Pathogen Management Plan.

- Identify how the following City of Wanneroo Management Plans are implemented within the Park and assess any gaps, through the YICM Annual Review process:
 - Weed Management Policy
 - Pathogen and fire management matters, through their inclusion in specific Management Orders, and tenders for natural areas for individual conservation reserves.
- Continue coordination of pest animal management including fox, feral cat, rabbit and European honey bee in liaison with the Department of Parks and Wildlife.

Targets / Timeframes

Flora and fauna surveys undertaken in priority areas of Yellagonga Regional Park by 2018.

City of Joondalup Fire Management Plan developed by December 2015.

City of Joondalup Weed Management Plan developed by December 2015.

City of Joondalup Pathogen Management Plan annual progress reporting conducted in June of each year.

City of Wanneroo Weed Management Policy review will take place biannually and Policy updated accordingly.

Project Partners

Department of Parks and Wildlife.

New Project

Project Description

Keeping up to date with developments in the area of integrated catchment management will ensure that the Cities are implementing best practice approaches in managing the Yellagonga Wetlands. There are a number of government and non-government groups and educational and research organisations within Western Australia and Australia that focus on building the capacity of local government to manage wetland areas and reduce impacts from the wider catchment.

The Cities should investigate opportunities to partner with stakeholders, industry groups and research institutions to enable the Cities to build capacity and gain information relating to best practice approaches to integrated catchment management planning.

The Friends of Yellagonga Regional Park are a group of local conservation volunteers that make a valuable contribution towards the conservation of biodiversity by helping to protect, preserve and enhance the site. The Friends of Yellagonga Regional Park conduct a variety of activities such as planting local endemic species, removal of introduced species and site maintenance. The Cities support and encourage the Friends Group through the provision of training, information and financial assistance.

Information sharing regarding Yellagonga Regional Park is conducted with the community by both Cities liaising with the Yellagonga Regional Park Community Advisory Committee facilitated by the Department of Parks and Wildlife which includes participation by representatives of the Friends of Yellagonga Regional Park.

Project Objectives

To ensure that the Cities are well informed of developments in integrated catchment management.

Scope

The project will:

- Increase support for the City in implementing integrated catchment management activities.
- Increase knowledge of best practice approaches to integrated catchment management.

Targets / Timeframes

Regular updates of YICM Plan projects provided by both Cities at the Yellagonga Regional Park Community Advisory Committee meetings held quarterly.

Project Partners

Relevant State government agencies.

4.2 INDIVIDUAL PROJECTS

Individual Projects will be undertaken separately by the relevant individual City.

CITY OF JOONDALUP PROJECTS

Yellagonga Ecotourism and Community Awareness

New Project

Project Description

The City of Joondalup has completed the initiatives outlined in the Yellagonga Community Awareness Program 2009–2014 including the Yellagonga School Program, World Wetlands Week initiatives and Water Quality Awareness programs. Other initiatives have included various projects to prevent hand feeding of wildlife, increase awareness of the issues of the long-necked turtles, pest animals and disease, encourage responsible pet ownership, promote sustainable gardening, investigate greener business accreditation programs and enhance community fire-watch.

The City has also provided ecotourism experiences through free tours and activities focused on fauna, Aboriginal cultural heritage, wetland ecology and birdwatching. An updated Yellagonga Regional Park Travelsmart map and interpretive signage have also been produced.

Future Yellagonga community awareness and ecotourism initiatives are to be delivered through the City of Joondalup's *Think Green* Environmental Education Program (EEP). These initiatives will target local residents and the broader community with an aim to enhance appreciation of the conservation significance of this important local wetland region.

The Project's objectives and scope, outlined below, are specific to activities delivered in the Yellagonga Catchment.

Project Objectives

- Develop and implement initiatives and projects that aim to increase the community's understanding of environmental issues affecting the Yellagonga Catchment.
- Increase the community's access to ecotourism experiences by delivering biodiversity and cultural heritage related initiatives within the Yellagonga Catchment Area.
- Reduce adverse community impacts on the Yellagonga Wetlands through the provision of information and resources addressing the key threats to the area.

Scope

The project delivery for Yellagonga Regional Park will include:

- 'Nightstalk' Fauna Tours
- Aboriginal Cultural Heritage and Bushtucker Tours
- Other tours and presentations to raise community awareness of the Park e.g. birdwatching and flora tours
- Sustainable gardening community workshops to encourage reduced water and

fertiliser use and native plantings adjacent the Yellagonga Wetlands

- Yellagonga school and community educational resources available on the City's website
- Ongoing distribution and displays of existing and new brochures and posters to raise awareness of key Yellagonga conservation issues.

Targets / Timeframes

Think Green Environmental Education Program delivered in accordance with agreed timeframes.

Project Partners

Relevant tour guides, community groups, State government agencies.

DRAFT

Existing Project

Project Description

Urbanisation has resulted in many impervious surfaces, with traditional piped drainage networks and altered topography, which has significantly changed the natural hydrological regime in the Yellagonga Wetlands. The direct discharge of stormwater into wetlands via piped outfalls is considered to be an ongoing source of pollution into these systems.

The City of Joondalup has completed an upgrade of all its outfalls in the Yellagonga Catchment as part of the implementation of the YICM Plan 2009-2014. To further improve the quality of water infiltrating to groundwater the City is delivering upgrades to sump infrastructure through the Stormwater Drainage Program - Sump Beautification Project. The project aims to further improve biofiltration of City sumps and increase amenity.

The City has identified a number of sumps adjacent to the Yellagonga Wetlands that require improvement or upgrading, these include those located in Edgewater, Joondalup, Kingsley and Woodvale.

Project Objectives

- Manage quality and quantity of stormwater in the Yellagonga Catchment, prior to reaching Yellagonga Wetlands.
- Protect Yellagonga Wetlands from contaminants.
- Improvement of sumps adjacent the Yellagonga Wetlands within the City of Joondalup to effectively manage water quality and quantity.

Scope

The sumps will be assessed, ranked and prioritised based on criteria such as environmental impact, flooding risk and visual improvement. The Program for upgrading of sump infrastructure will occur in accordance with the City of Joondalup Stormwater Management Policy.

Targets / Timeframes

- Sump Beautification Project selection of sites to be completed by December 2015.
- Review of the City's Stormwater Management Policy by 2015.

Project Partners

Department of Water.

Conservation Maintenance Schedule

Existing project

Project Description

The City of Joondalup has management responsibility for over 500 hectares of natural bushland contained within 108 reserves. The bushland is comprised of coastal vegetation, remnant bushland fragments in urban areas, and small areas of wetland vegetation. The City of Joondalup also undertakes extensive detailed surveys of their bushland as part of the Local Biodiversity Program. The bushland is prioritised for management according to the condition and ecological values of the site. The City of Joondalup managed sites in Yellagonga Regional Park include Neil Hawkins Park and a small section of bushland to the south and Picnic Cove Park. The majority of Yellagonga Regional Park is managed by the Department of Parks and Wildlife particularly through its conservation maintenance program.

The City's Conservation Maintenance Schedule includes the planning and implementation of conservation works to ensure its two sites within Yellagonga Regional Park are maintained and enhanced to achieve quality recreational amenity, optimal vegetation condition and wildlife habitat.

Shared information and coordination of conservation works are undertaken through the Yellagonga Regional Park Community Advisory Committee facilitated by the Department of Parks and Wildlife.

Project Objectives

- Maintain habitat for wildlife.
- Protect and enhance local native flora.
- Maintain recreational parks to a high standard.

Scope

The project will implement a Conservation Maintenance Schedule that ensures regular programmed visits to all sites.

Targets / Timeframes

Conservation maintenance activities implemented in accordance with the approved Conservation Maintenance Schedule. The Conservation Maintenance Schedule reviewed annually.

Project Partners

Department of Parks and Wildlife.

New Project

Project Description

Planning for the future impacts of climate change is an important emerging issue for local government. Climate change affects a number of areas that local government is responsible for managing including infrastructure, health services, water management, emergency management and the natural environment.

The effects of climate change will vary in scale and nature across the globe but will impact on temperature, rainfall, intensity and frequency of extreme weather events, wind strength and patterns, and ocean temperatures and currents. In regards to the Yellagonga Wetlands water availability will continue to decline with reduced rainfall which will have a significant impact on the health and viability of the wetland areas.

The development and implementation of the City's Climate Change Strategy will assist the City to minimise and prepare for these impacts while increasing the resilience of the community and the natural environment. The Climate Change Strategy identifies a number of projects that will contribute to reducing the impact of future climates on the Yellagonga Wetlands including:

- Project 1.4 Rainfall Monitoring and Stormwater Management
- Project 1.5 Review of the Stormwater Management policy
- Project 3.1 Water Recycling Feasibility Study
- Project 3.2 Rain Sensor Program
- Project 3.3 Parks Redevelopment Program
- Project 4.1 Yellagonga Integrated Catchment Management Plan Review
- Project 4.4 City of Joondalup Fire Management Plan
- Project 5.9 City Water Plan
- Project 6.1 Mosquito Monitoring Program

Project Objectives

- Ensure relevant projects within the Climate Change Strategy that contribute to the resilience of the Yellagonga Wetlands are implemented.
- Ensure the implementation of the Climate Change Strategy takes into consideration the likely impacts on the Yellagonga Wetlands.

Scope

The relevant projects will be implemented in accordance with the Climate Change Strategy Implementation Plan and progress will be assessed on an annual basis.

Targets / Timeframes

Climate Change Strategy projects are to be delivered as per the Council approved Climate Change Strategy and annual progress reports presented to Council by June each year.

Project Partners

Relevant State government agencies.

Existing project

Project Description

Local Governments have scope to recognise and promote integrated catchment management through local planning processes including Local Planning Strategies and local planning policies developed under Local Planning Schemes.

The City's Local Planning Strategy (LPS) outlines the vision and strategic planning direction for the City over the next 15 to 20 years. The City's District Planning Scheme is the document that controls how land may be used within the City of Joondalup. The City is currently finalising its Local Planning Strategy and undertaking a review of the current *District Planning Scheme No. 2* (DPS2) with a view of putting in place a new Local Planning Scheme. The strengthening of integrated catchment management considerations into the next Local Planning Strategy will ensure that specific measures can be incorporated into the provisions of a local planning policy developed under the new Local Planning Scheme.

Project Objectives

- Ensure the City's next Local Planning Strategy adequately recognises and addresses impacts to the Yellagonga Wetlands.
- Ensure that integrated catchment management is considered in the City's land use planning decisions.

Project Scope

The project will include:

- Consideration of integrated catchment management principles and the impacts of development on the Yellagonga Wetlands in the next review of the City's Local Planning Strategy.
- Refer to the City's Stormwater Management Policy to set integrated catchment management standards for subdivision and planning approval processes to address the impacts of development on the Yellagonga Wetlands.

Targets / Timeframes

New Local Planning Strategy developed by 2019.

Project Partners

Relevant State government agencies.

CITY OF WANNEROO PROJECTS

Yellagonga Ecotourism and Community Awareness Program

New Project

Project Description

Environmental education across the community is vital to promote ownership and appreciation of the local environment. The Yellagonga Ecotourism and Community Awareness Program will develop discrete education initiatives, targeting schools, residents, communities, and visitors to the City, to address key environmental issues and encourage greater environmental stewardship by the community.

Project Objectives

- Increase the community's understanding of contaminant inputs into Yellagonga wetlands.
- Provide data upon which sound management decisions can be made.
- Reduce number of negative incidences associated with poor water quality.

Scope

The project will:

- Organise and run Catchment Education Days that provide local excursions and in-class activities for local schools.
- Engage the 'Beyond Gardens' team and arrange seminars and workshops that aim to encourage native landscaping and reduce fertiliser use in residential gardens.
- Identify key tourism features of Yellagonga Regional Park and investigate the development of a "Yellagonga Regional Park" information brochure for the City of Wanneroo.
- Implement the Wangara Industrial Area education and awareness program.
- Develop Catchment tours to highlight threats and issues.
- Seek funding to promote and run events in Yellagonga Regional Park.
- Organise and run other community events that benefit the wetland such as night stalks, spring guided walks, and winter planting days.

Targets / Timeframes

Community events and Ecotourism initiatives will be organized on a case by case basis throughout the year. Feedback on the number and type of events will be provided through the annual report to Council for YICM Plan projects.

Project Partners

Department of Parks and Wildlife.

Existing Project

Project Description

Urbanisation has resulted in many impervious surfaces, with traditional piped drainage networks and altered topography, which has significantly changed the natural hydrological regime in Yellagonga Wetlands. The direct discharge of stormwater into wetlands via piped outfalls is considered to be an ongoing source of pollution into these systems. Some drainage sub catchments consist of potentially greater polluting land uses than others, such as industry, poultry farming and horticultural practices.

The City of Wanneroo has recently commenced the upgrade of its stormwater infrastructure within the Yellagonga catchment. This initial work is to be continued with additional works being carried out within the remaining stormwater catchments that lead into the Yellagonga wetlands.

The YICM Plan has detailed many of the early elements required in the development of a Stormwater Management Plan for the Yellagonga catchment. These include:

- a) Stakeholder involvement and analysis of sub-catchments.
- b) Identification of catchment characteristics, condition and practices.
- c) Identification of the values of the receiving environment - Yellagonga Regional Park.
- d) Identification of the stormwater threats.
- e) Identification of priority sub-catchments for upgrade.

Formal and detailed management of the stormwater infrastructure within the Yellagonga catchment area has been set out within the City of Wanneroo's Infrastructure Directorate's 10 Year Plan. The process will now be completed over the course of a number of years, with details of the process outlined in the scope of this project.

Project Objectives

- Manage quality and quantity of stormwater in the Yellagonga catchment, prior to reaching Yellagonga wetlands.
- Protect Yellagonga wetlands from contaminants.
- Upgrade all appropriate infrastructure in the catchment to effectively manage water quality and quantity.
- Complete Gap Analysis and stormwater drainage catchment study by 30 June 2015.
- Consider a phased roll out of the outcomes of the stormwater catchment study, subject to funding allocations.

Scope

The project will produce a Stormwater Management Plan for each sub-catchment within the Yellagonga catchment following the process outlined in the Department of Water's Stormwater Management Manual for Western Australia. Each Stormwater Management Plan will:

- Identify management objectives.
- Identify the management options.
- Develop management actions.
- Include an Implementation Plan.

In addition to the works to be carried out within the individual sub-catchments, the following is to be completed over the course of the project as a whole:

- Summarise past design strategies and extent to which they were implemented.
- Identify shortcomings/failings in previous strategies.
- Implement recommendations of the Gap Analysis and Stormwater Drainage Study.
- Monitor water quantity and quality of water entering the Wangara Sump.

Targets / Timeframes

Appoint a consultant to complete a Gap Analysis and Stormwater Drainage Catchment Study by June 2015. The Gap Analysis Study will identify individual actions that will need to be prioritised for further implementation of the project.

Project Partners

Nil

Existing Project

Project Description

Historical and existing land uses may result in contamination of soils throughout the Yellagonga catchment. For example, the previous use of persistent pesticides or inappropriate disposal of industrial compounds may have an adverse effect on the quality of the groundwater entering the wetlands.

Lot 9005 Motivation Drive, Wangara has been classified as “*Possibly contaminated, investigation required*” by the Department of Environment Regulation (DER). Other suspected sites in the Yellagonga catchment on the Wanneroo side are yet to be classified by the DER.

Site investigations, involving sampling and analysis, have commenced for the City of Wanneroo owned contaminated site at Lot 9005 Motivation Drive, Wangara.

Project Objectives

- Identify any contaminated sites owned or managed by the City of Wanneroo in the Yellagonga catchment.
- Remediate City owned or managed contaminated sites in the Yellagonga Catchment.

Scope

The project will:

- Collate classification of City owned or managed potentially contaminated sites in the Yellagonga catchment.
- Engage consultants to conduct sampling and analysis of contaminated sites classified by the Department of Environment and Conservation (DEC) as requiring further investigation.
- Develop plans for remediation works if necessary.

Targets / Timeframes

Appoint a consultant to investigate and assess the next stage of contaminated site investigations for Lot 9005 Motivation Drive in the 2014/2015 financial year.

Project Partners

Department of Environmental Regulation.

Existing Project

Project Description

The City of Wanneroo has over 140 conservation reserves under its control including 32 kilometres of Coastal reserves, numerous Wetland reserves and Bushland reserves. In all approximately 2,500 hectares of land are under management. In 2003, a Biodiversity Assessment was carried out on 94 conservation reserves in the City of Wanneroo, which highlighted the management needs of these reserves to maintain or improve biodiversity values.

It was recognised that in order to manage the City of Wanneroo's conservation areas in an environmentally responsible manner that staffing numbers needed to increase and formalised procedures be developed to reflect these environmental responsibilities.

The Capital Works component of this project will include the installation of infrastructure such as fencing and controlled access, wetland bank stabilization, control of exotic flora species and planting and revegetation works.

The maintenance of reserves within the Yellagonga catchment includes pest and weed management, removal of dead trunks and trees for fire management purposes, and extensive revegetation works.

Project Objectives

- Ensure that natural areas are maintained and enhanced.
- Improve and maintain habitat for local wild life.
- Protect unique and diverse flora for future generations.
- Rehabilitate key aspects of the Regional Park and its catchments.

Scope

The project will:

- Maintain and improve biodiversity values of conservation reserves and other natural areas within the Regional Park and associated catchments.
- Develop staff infrastructure that meets the above objectives.
- Ensure constant improvement on existing maintenance schedules and arrange regular programmed visits to all sites.
- Rehabilitate key areas within the Regional Park and surrounding catchments by undertaking the following:
 - Revegetation.
 - Pest and weed control.
 - Habitat creation and development of fauna protection areas.

Targets / Timeframes

Maintenance Schedules for Conservation Reserves are to be reviewed monthly and aim to ensure that all Conservation Reserves are attended to once per fortnight to ensure hazards

are identified and actioned in a timely manner.

Capital Works are to aim to reduce the percentage cover of invasive species such as Typha and reintroduce displaced native vegetation in order to increase species richness over time. No timeframe is set due to the ongoing nature of the works.

Other targets include the reclamation of dryland turf areas for return to historical riparian fringe ecosystem. No timeframe is set due to the ongoing nature of the works.

Project Partners

Nil

DRAFT

Existing Project

Project Description

The City's Local Planning Framework refers to the various planning instruments which collectively guide the future land use and development in the district. The main elements of the current Framework are the District Planning Scheme No.2 (DPS 2), Local Planning Policies (LPP's) and Structure Plans prepared under DPS 2.

A new Framework is now being prepared that involves the preparation of a Local Planning Strategy, review of DPS 2 and its associated LPP's, and a review of a number of other City strategies and policies which are now considered dated.

Project Objectives

- To provide input into the preparation of the new Local Planning Framework aimed at ensuring that the new Framework has proper regard to, and includes appropriate measures for, the protection of the environmental values of Yellagonga Regional Park, particularly in respect to the planning and control of land use and development in the surface and groundwater catchment of the Yellagonga wetlands.
- Achieve sustainable development and use of land across the City of Wanneroo through integrated land use planning.
- Formalise and strengthen policy statements and positions in order to guide land use planning and provide certainty to developers and users of land.
- Ensure that the City's Planning Framework can provide positive environmental outcomes for the City's natural environments.

Scope

The Local Planning Framework will assist in reporting on the ability of new developments to meet the City's community aspirations and promises as set out in the Local Planning Framework. The key elements of the new Framework are:

- New Local Planning Strategy.
- New Local Planning Scheme No. 3.
- New and revised Local Planning Policies.

Targets / Timeframes

To have final versions of the Local Planning Scheme No. 3 and the Local Planning Strategy endorsed by the Western Australian Planning Commission by June 2018. However, this is approximate and actual timing of the projects will depend on a range of factors.

Project Partners

Department of Planning.

New Project

Project Description

In January 2011, the East Wanneroo Structure Plan (EWSP) was released by the State planning agencies. The EWSP has identified areas of current rural and State Forest land (which is generally located to the east of the existing residential areas stretching from Hocking / Pearsall in the south to Banksia Grove in the north) as potential urban and industrial land uses. Most of this land is expected to fall within the broader groundwater catchment of the Yellagonga wetlands.

Over coming years, further detailed planning of this area will be done to eventually enable it to be developed for urban and industrial uses. This detailed planning will result in the preparation of a Planning Framework specifically for the EWSP area, which will include District and Local Structure Plans, which will ultimately guide the future development of this area.

Project Objectives

- To provide input into the preparation of the Planning Framework for the EWSP area aimed at ensuring that the new framework has proper regard to, and includes appropriate measures for, the protection of environmental values of the Yellagonga Regional Park, particularly in respect to the planning and control of land use and development within the broader groundwater catchment area that encompasses the Yellagonga wetlands.

Scope

Key elements of the new Planning Framework which the above input will be important for are:

- New land use zonings under the Regional and Local Planning Schemes.
- New District Structure Plans.
- New Local Structure Plans.
- Environmental studies and Management Plans prepared in support of, and in order to alleviate impacts of the above planning elements.

Targets / Timeframes

Rezoning of areas from their existing land uses to Urban under the Metropolitan Region Scheme (MRS) should occur by December 2016, with approval of District Structure Plans in the East Wanneroo area to be completed by December 2018. However, this is approximate and actual timing of the projects will depend on a range of factors.

Project Partners

Department of Planning.

Appendix 1 – Key Achievements of YICM Plan 2014-2019

Joint Projects

- Management Framework and Memorandum of Understanding
 - A Memorandum of Understanding and Management Framework were developed at the beginning of the YICM Plan to ensure commitment from both Cities to deliver the Plan.
- Water Quality Mapping and Monitoring Program
 - Surface water of the Yellagonga Wetlands has been sampled on a monthly basis to determine nutrient and metal levels since 2010 to collate regular water quality data and assess the condition.
 - Further groundwater bores were installed by the City of Joondalup to enable the commencement of the groundwater monitoring program in 2012.
 - Annual reporting of issues and recommendations to executive management.
 - Recommendations to research further major pollutant source points and to improve water quality, have been investigated or implemented to determine nutrient and metal levels.
 - A four year review is underway of all the research undertaken for the Water Quality Mapping and Monitoring Program.
- Scientific Investigations
 - Completion of the research project: *Nutrients Entering and Leaving Beenyup Swamp over the Periods of Water Flow* and analysis of metal samples taken in association with this project. Reporting of issues and recommendations to executive management.
 - The Midge Steering Group in partnership with external stakeholders undertook investigations regarding the installation of 'floating vegetated islands' at Lake Goollelal as a potential water quality improvement initiative.
- Acid Sulphate Soils
 - A three stage site specific acid sulphate soils investigation has been undertaken and arrangements for seeking consultancy services to develop an acid sulphate soils management plan for this area is in process.
- Yellagonga Resource Allocation Strategy
 - A gap analysis and Resource Allocation Strategy schedule was prepared in liaison with the Department of Parks and Wildlife. The tasks of this schedule have been reallocated under future projects.

City of Joondalup Individual Projects

- Yellagonga Community Awareness Program including delivery of:
 - Yellagonga School Program of free fauna and wetland ecology excursions/ incursions and educational resource materials.
 - World Wetlands Week Program of community displays, promotion of the Park at the annual WA Wetland Management Conference and community tours.
 - Water Quality Awareness Program including the completion of the Green Frog Drain Stencilling Program in collaboration with the Friends of Yellagonga and education of stormwater pollution including catchment model demonstrations.
 - Prevention of Hand-feeding Wildlife Campaign including improved signage, explanatory brochures and posters.
 - Turtle Awareness campaign including residential deliveries of brochures raising awareness of the long-necked turtle vulnerabilities and support available and successful applications of road signage.
 - Responsible Pet Ownership campaign has involved the production and delivery of flyers to promote the wildlife conservation significance of the Park and responsible management of cats and dogs.
 - Sustainable Gardening Workshops to encourage local native plantings and reduced fertiliser and water use for areas adjacent the Park.
 - Community Fire-watch Program involving research and distribution of arson targeted wildfire data of the Park to Neighbourhood Watch coordinators.
 - Picnic Cove interpretive signage was completed to promote the Yellagonga catchment and wildlife.
- Yellagonga Ecotourism
 - Continuation of ecotourism initiatives including evening fauna spotting, bird watching and Aboriginal cultural heritage tours.
- Stormwater Management Plans
 - All outfalls within the City's boundaries that discharged directly into the Yellagonga Wetlands were upgraded by 2009 and only future sump upgrades were required. Sump upgrades have been undertaken at Neil Hawkins Park and Lakeway Drive.
 - A new Stormwater Management Policy was adopted by Council in August 2012.
- Local Biodiversity
 - Biodiversity linkages reflecting plant communities and soil types between the Yellagonga Wetlands and the coast have been planted through the Iconic Landscaping Project.
 - A Pathogen Management Plan was completed in 2013 to be implemented

within City managed areas of the Park.

- Conservation Maintenance Schedule
 - Conservation maintenance of the two City managed sites within the Park, Neil Hawkins Park (including bushland south) and Picnic Cove, included weed mapping, ongoing weeding, planting, fencing and litter removal and nesting box installation for Carnaby's Black Cockatoos.
- Water Plan
 - The City of Joondalup monitors and reports monthly on its groundwater use to ensure allocations set by the Department of Water and the targets outlined in the City Water Plan are met. Further water efficiency projects that benefit the Yellagonga Wetlands include soil moisture monitoring, a bore maintenance program, a rain sensor program and irrigation upgrades.

City of Wanneroo Projects

- Stormwater Management Plans
 - Stage 1 of the Wangara Sump upgrade has been completed, with stage 2 of the upgrade in the design process.
 - Design stage of the Church Street Drain has been completed.
 - Stormwater infrastructure within Luisini Park has been completed as a part of the upgrade to stormwater infrastructure within the eastern surface water catchment area of Lake Joondalup.
- Green Frog Stenciling
 - The Green Frog Stenciling program was completed in 2011 with support from the Friends of Yellagonga.
- Local Biodiversity
 - The City of Wanneroo's Local Biodiversity Strategy (2011-16) was adopted by Council on 3 May 2011. The Local Biodiversity Strategy (LBS) sets targets for the protection of native vegetation complexes within the City. For wetlands, the LBS states that all vegetation associated with wetlands in good or better condition should be protected.
- Water Management Strategy
 - The City's Public Open Space Policy was adopted in 2010 and includes provisions relating to urban water management issues and water sensitive urban design. This translates to an increase in the quality of water entering the catchment through stormwater.
 - The City's Urban Water Management Policy was adopted by Council in 2013. This Policy ensures that development within the City optimises the use and management of urban water resources such as rainwater, stormwater, groundwater, drinking water and wastewater. This provides assurance that the water entering the wetlands through the ground is not contaminated by development further up catchment.
- Water Conservation Plan

- The City's Water Conservation Plan was endorsed by Council on 7 February 2012. This Plan allows the City to achieve water use efficiency by improving water usage and management.

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Appendix 2- Strategic Context

Local Context

City of Wanneroo

The *Building a Future Together - Strategic Community Plan 2013/14 – 2022/23* is the City of Wanneroo's long-term vision capturing the aspirations of the community and describing the City's objectives. It also provides strategic guidance to the City regarding priority focus areas and direction and informs the Corporate Business Plan. This is also the key document for Council to track and report back to the community on progress. The Plan includes four pillars, one of which is 'Environment'. The aspiration identified for the Environment pillar is for 'A healthy and sustainable natural and built environment'.

The development and implementation of the Yellagonga Integrated Catchment Management Plan 2014-2019 will help the CoW achieve this aspiration. Other CoW strategic documents, policies and local laws that are relevant to the YICM Plan 2014-2019 are listed in Table 7.

Local Biodiversity Strategy 2011–2016

Implementation of the Local Biodiversity Strategy will help integrate biodiversity protection into land use planning, commit to ongoing action and proposes new projects to improve biodiversity conservation in the City of Wanneroo.

Local Environment Plan (LEP) 2009-2014

Strategies of the LEP provide the benchmark for operational plans, projects, and proposals. The intent of the LEP is to ensure that the City's operations meet the community's standards for environmental performance, and to effectively manage the impact and behaviour of those stakeholders whom the City can influence.

Smart Growth Strategy

The Smart Growth Strategy was developed to more effectively manage growth in the City, in both new and existing suburbs. The strategy has six key principles, one of which is Long Term Health of the Environment.

Local Planning Policy 4.1: Wetlands (2010)

The objectives of the Policy are to ensure development within the City of Wanneroo appropriately protects and manages the environmental attributes of wetlands and also recognises the value and benefit of wetlands to the local environment and community.

Local Planning Policy 4.8: Tree Preservation Policy (2006)

To provide a mechanism to protect significant trees of the City within the following specified areas: vacant land and bushland which will be subject to future development; and existing and proposed public open space reserves.

Animals Local Law 1999 and Animals (Amendment) Local Law 2008

Provides for the regulation, control and management of the keeping of animals within the City of Wanneroo. The effect of this local law is to establish the requirements with which owners and occupiers of land within the district must comply in order to keep animals and provides the means of enforcing the local law.

Table 7 City of Wanneroo local law and policy relevant to the YICM Plan 2014-2019

City of Joondalup

Joondalup 2022: Strategic Plan 2012–2022 is the City's long-term strategic planning document; outlining its commitment to achieving the vision and aspirations of its community and regional stakeholders. One of its key focus areas is the natural environment which contains the aspirational outcome:

The City is a global leader in adaptive environmental management. It works closely with the community to protect and enhance the natural environment, while celebrating and showcasing its natural assets to the world.

The development and implementation of the Yellagonga Integrated Catchment Management Plan 2014-2019 will help the CoJ achieve this aspirational outcome. Other CoJ strategic documents, policies and local laws that are relevant to the YICM Plan 2014-2019 are listed in Table 8.

Biodiversity Action Plan 2009–2019

The Plan has been developed to ensure the value of its natural assets are recognised and to provide direction for the City's biodiversity management activities over the next ten years.

Environment Plan 2014-2019

Guides the City's strategic response to local environmental pressures. The purpose of the Plan is to ensure that the City's operations are delivered in an environmentally sustainable manner and that the City takes measures to effectively influence positive environmental behaviours within the community.

Climate Change Strategy 2014-2019

Provides guidance to the City's climate change management activities and has a dual purpose of both mitigation (to continue to reduce greenhouse gas emissions to minimise the severity of climate change) and adaptation (to implement strategies to ensure the City is prepared and able to adapt to current and future impacts of climate change).

Sustainability Policy

The objective of the policy is to outline the City's commitment to integrating sustainable practices into all local government functions and services.

Stormwater Management Policy

The objective of the policy is to ensure stormwater is managed to protect environmental, social and economic values and to facilitate the integration of water sensitive design principles into planning and development within the City of Joondalup.

Animals Local Law 1999 and Animals (Amendment) Local Law 2010

Provides for the regulation, control and management of the keeping of animals within the City of Joondalup. The effect of this local law is to establish the requirements with which owners and occupiers of land within the district must comply in order to keep animals and provides the means of enforcing the local law.

Table 8 City of Joondalup Local Law and Policy Relevant to the YICM Plan 2014-2019

Regional Context

Regional policy documents relevant to the management of the Yellagonga catchment are identified in Table 9.

Bush Forever (2000) Department of Planning

The aim is to provide a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making.

Bushland Policy for the Perth Metropolitan Region (State Planning Policy No.2.8) (2010)

The aim of the policy is to provide a policy and implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed and integrated with broader land use planning and decision-making.

Draft Gngalara Sustainability Strategy (2009)

A cross-government initiative working on an action plan that will ensure the sustainable use of water for drinking and commercial purposes and to protect the environment.

Table 9 Regional Policy Relevant to the YICM Plan 2014-2019

State Context

State legislation and policy documents relevant to the management of the Yellagonga catchment are identified in Table 10.

Environmental Protection Act 1986

Provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

Wildlife Conservation Act 1950

Provides for the conservation and protection of wildlife.

Planning and Development Act 2005

Provide for a system of land use planning and development in the State and for related purposes.

Water Resources (State Planning Policy 2.9) (2006)

Provides clarification and additional guidance to planning decision-makers for consideration of water resources in land use planning strategy.

Better Urban Water Management Framework (2008)

Facilitates better management of urban water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning system and provides guidance on the implementation of State Planning Policy 2.9 Water Resources.

Securing Western Australia's water future – A position paper (2013)

Sets out a proposed legislative and policy framework to help deliver new water management solutions in Western Australia.

Table 10 State Policy and Legislation Relevant to the YICM Plan 2014-2019

National Context

National legislation and policy documents relevant to the catchment management are identified in Table 11.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places.

Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*, Commonwealth of Australia (2014)

This national threat abatement plan came into force on 31 January 2014 and addresses the key threatening process 'Dieback caused by the root-rot fungus *Phytophthora cinnamomi*, which is listed under the Commonwealth *EPBC Act*.

Australia's Biodiversity Conservation Strategy 2010 – 2030, Commonwealth of Australia (2010)

The Strategy is a guiding framework for biodiversity conservation for all sectors - government, business and the community. The Strategy sets out priorities which will direct efforts to achieve healthy and resilient biodiversity and provide us with a basis for living sustainably.

Australia's Biodiversity and Climate Change. A strategic assessment of the vulnerability of Australia's biodiversity to climate change. Commonwealth of Australia (2009)

Is an assessment of the vulnerability of Australia's biodiversity to climate change, commissioned by the Australian Government to help increase our understanding of how to help Australia's rich biodiversity adapt to climate change.

Australia's Native Vegetation Framework, COAG (2012)

This Framework is a joint initiative of the Australian, state and territory governments and outlines a coordinated national approach to native vegetation management and provides a mechanism through which the native vegetation management commitments agreed to by all Australian governments can be progressed.

Table 11 National Policy and Legislation Relevant to the YICM Plan 2014-2019

International Context

International policy documents relevant to catchment management are identified in Table 12.

Japan Australia Migratory Birds Agreement (Australia Treaty Series 1981 No.6) (JAMBA)

The JAMBA agreement lists terrestrial, water and shorebird species which migrate between Australia and Japan. The agreement requires the parties to protect migratory birds and includes provisions for cooperation on the conservation of threatened birds.

China Australia Birds Agreement (Australian Treaty Series 1988 No.22) (CAMBA)

The CAMBA agreement lists terrestrial, water and shorebird species which migrate between Australia and China. The agreement requires the parties to protect migratory birds.

Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA)

The ROKAMBA formalises Australia's relationship with the Republic of Korea in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat.

The Convention on the Conservation of Migratory Species of Wild Animals (1983) (Bonn Convention)

Is an intergovernmental treaty that aims to conserve terrestrial, aquatic and avian migratory species throughout their range. Migratory species which are native to Australia and are included in the appendices to the Bonn Convention.

The Convention on Wetlands of International Importance (1971) (Ramsar Convention)

Is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Australia currently has 65 wetlands of international importance listed under the Ramsar Conventions (Yellagonga is not one of them).

Table 12

International Legislation Relevant to the YICM Plan 2014-2019

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5.0 REFERENCES

Allen, A.D., 1976, The Swan Coastal Plain – Hydrogeology of superficial formation in *Groundwater resources of the Swan Coastal Plain*, Carbon, B.A. (Ed), CSIRO Division of Land Resources Management, pp 12-33.

Australian Government, 2014, *Atlas of Living Australia*, accessed on 6 May 2014: http://biocache.ala.org.au/explore/your-area#31.7840219|115.80041510000001|12|ALL_SPECIES.

Bamford, M.J. and Bamford, A.R., 1990, *Yellagonga Regional Park: A preliminary survey of the vertebrate fauna*.

Bekle, H., 2007, 'Birds,' in *Yellagonga wetlands; in A study of the water chemistry and aquatic fauna*, Kinnear, A and Garnett, P (Eds), Research Report No. 1 Centre for Ecosystem Management, Edith Cowan University, Perth Western Australia, pp. 89-112.

Bickford, S and Gell, P., 2005, Holocene vegetation change, Aboriginal wetland use and the impact of European settlement on the Fleurieu Peninsular, South Australia, *The Holocene*, **15**, pp. 200-215.

Bunny, B.J. and Mouritz, M., 1995, *Urban integrated catchment management*, City of Canning, Perth Western Australia.

Bureau of Meteorology, 2014, *Monthly summary climate statistics for Perth Airport Weather station*, accessed on 11 April 2014: http://www.bom.gov.au/climate/averages/tables/cw_009021.shtml.

City of Joondalup, 2014, *Draft Climate Change Strategy 2014-2019*, Perth, Western Australia.

Climate Commission, 2011, *The Critical Decade: Western Australia climate change impacts*, Climate Commission.

Congdon, R., 1979, *Hydrology, nutrient loading and phytoplankton in Lake Joondalup: a feasibility study*, Department of Environment and Conservation, Perth, Western Australia, Bulletin 67.

Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2007, *Climate Change in Australia – Technical Report*, CSIRO.

Davis, J.A. Rosich, R.S. Bradley, J.S. Grows, J.E. Schmidt, L.G. and Cheal, F., 1993, Wetland Classification on the basis of water quality and invertebrate community data, In *Wetlands of the Swan Coastal Plain (vol 6.)* pp.242, Water Authority of Western Australia and the Environmental Protection Authority.

Department of Conservation and Land Management and the Cities of Joondalup and Wanneroo, 2003, *Yellagonga Regional Park Management Plan 2003-2013*, prepared for the

Conservation Commission of Western Australia, Perth Western Australia.

Department of Environment, 2004, *Perth Groundwater Atlas*, Second Edition, Perth Western Australia.

Department of Environment and Conservation, n.d., *What are acid sulfate soils?* Acid Sulfate Soils, Fact Sheet 1.

Department of Water, 2008a, *Perth Regional Aquifer Modeling Systems (PRAMS) Model Development: Hydrology and Groundwater Modelling*, Report No. HG 20.

Department of Water, 2008b, 'Review of Ministerial Conditions on the groundwater resources of the Gnangara Mound,' Draft, Department of Water, Water Allocation Branch, Perth.

Hamann, J.A., 1992, *Lake level changes within the Yellagonga Regional Park: A historical perspective*, Honours thesis, Edith Cowan University, Perth Western Australia.

Hill, A.L., Semeniuk, C.A., Semeniuk, V and Del Marco, A., 1996, *Wetlands of the Swan Coastal Plain (vol 2B)*, Water and Rivers Commission, Department of Environmental Protection, Perth.

Hudon, C., 2004, 'Shift in wetland plant composition and biomass following low-level episodes in the St. Lawrence River: Looking into the future,' *Canadian Journal of Fisheries and Aquatic Sciences*, **61**, pp. 603-617.

Indian Ocean Climate Initiative (IOCI), 2010, *WA Rainfall – What the past can tell us, and what the future may hold*, IOCI.

Keighery, G., 2002, 'The enemy within: native environmental weeds of Western Australia,' in *13th Australian Weeds Conference – Papers and Proceedings*, H. S. Jacob, J. Dodd, J.H. Moore (Eds), Plant Protection Society, Perth, pp. 93-95.

Kinnear, A and Garnett, P., 1997a, 'Macroinvertebrates' in *Yellagonga wetlands; in A study of the water chemistry and aquatic fauna*, Kinnear, A and Garnett, P (Eds), Research Report No. 1 Centre for Ecosystem Management , Edith Cowan University, Perth Western Australia, pp. 63-88.

Kobryn, H.T., 2001, *Land use changes and the properties of stormwater entering a wetland on a sandy coastal plain in Western Australia*, PhD Thesis, Murdoch University, Perth.

McArthur, W.M and Bartle, G.A., 1975-76, *Landforms and soils and the Perth metropolitan north-west corridor – Western Australia*, Land Resources Management series No. 5. Department of Lands and Survey and the CSIRO Division of Land Resources Management.

National Climate Change Adaptation Research Facility (NCCARF), 2011, *Report Card of Climate Change and Western Australian Aquatic Ecosystems*, Eds. K. Kauhanen, J. Chambers and F. D'Souza.

Noss, R.F and Csuti, B., 1997, 'Habitat fragmentation,' in *Principles of conservation biology (2nd edn)*, G.K. Meffe and C.R. Carroll, Sinauer Associates Inc (Eds), Massachusetts, pp.

269-307.

Ove Arup and Partners, 1994, *Yellagonga Regional Park – Drainage Study*, Unpublished Report, Perth Western Australia.

Regeneration Technology, 2002, 'Weed control and revegetation plan,' Report prepared for Department of Conservation and Land Management.

Risbey, D.A., 2000, *The impact of cats and foxes on small terrestrial vertebrates and the control of feral cats on Heirisson Prong*, PhD Thesis, Murdoch University, Perth, Western Australia.

Saunders, G., Coman, B., Kinnear, J and Braysher, M., 1995, *Managing vertebrate pests: Foxes*, Australian Government Publishing Service, Canberra.

Van der Welle, M.E.W., Roelofs, J.G.M, Op den Camp, H.J.M and Lamers, L.P.M., 2007, 'Predicting metal uptake by wetland plants under aerobic and anaerobic conditions,' *Environmental Toxicology and Chemistry*, **26**, pp. 686-694.

Vear, K. and Dell, B. (eds), 2004, *Arresting Phytophthora Dieback: The Biological Bulldozer*, World Wild Fund for Nature (WWF) Australia and Dieback Consultative Council, Perth, WA.

Western Australia Water Authority, 1995, 'Review of proposed changes to environmental conditions,' Gnangara Mound Groundwater Resources (Section 46), Water Authority of Western Australia.

Western Australian Planning Commission, n.d., *Bush Forever site 299*, accessed on 11 April 2008: <http://www.wapc.wa.gov.au/Publications/251-299.pdf?id=1117>.

Western Australian Planning Commission (WAPC), 2005, *Western Australia Tomorrow: Population Projections for Planning Regions 2004 to 2031 and Local Government Areas 2004 to 2021*, accessed on 2 April 2014: http://www.planning.wa.gov.au/dop_pub_pdf/wa_tomorrow.pdf.

Whitely, J.D., 2004, *Autocatalyst-derived platinum group elements in the roadside environment: Occurrence, mobility and fate*, PhD Thesis, Murdoch University, Perth, Western Australia.